Stability of Dental Arch Expansion in the Deciduous Dentition

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Thirteen patients with deciduous dentition and more than 3mm intercuspid arch length deficiency are expanded and followed, with controls, for 6 years. Arch perimeter and width at permanent cuspids and bicuspids appear to be slightly greater, and lower incisors are positioned somewhat more forward on the mandible.

KEY WORDS: • DECIDUOUS DENTITION • EARLY TREATMENT • • EXPANSION •

Extract or expand? These are the options for the orthodontist who must treat crowding of the teeth and inadequate dental arch space. Preferences have vacillated over the years between a strict non-extraction approach and extraction of teeth in the majority of cases.

One extreme viewpoint is that tooth and jaw size are genetically predetermined and therefore immutable. Extraction of selected teeth is therefore necessary in order to provide adequate space in the dental arch to accommodate the remaining teeth. The other extreme is the assumption that jaw size is not immutable, that crowding is a result of failure of the jaws to develop fully to accommodate the teeth, and that treatment can therefore produce any required amount of space.

The latter viewpoint suggests that since jaw size is to some extent environmentally determined and not under exclusively genetic control, early orthodontic intervention can be directed toward full development of the bony support of the dental arch to accommodate the entire dentition. If widening of the dental arch is accomplished very early, before eruption of the permanent incisors, a permanent and stable increase in arch size may be obtained because the part of the jaw which contains the deciduous teeth is transformed by subsequent growth and

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development into the more basal portion of the jaw structure. It is also suggested that such early expansion may effect a modification of the muscular environment.

— Literature Review —

A dominant orthodontic view through the 1940's and 1950's is expressed by NANCE (1947), TWEED (1945), AND STRANG (1949), whose prior experience found that expansion of the dental arches did not produce stable treatment results in the correction of dental crowding.

Another viewpoint was expressed by BARNES (1956), who wrote of his twenty-four years of experience with expansion of the deciduous arches with stable results several years out of retention. The most successful expansion results were achieved when treatment was started between 4yrs and 7yrs of age. HOWES (1957) also advocated early expansion of the deciduous dentition, especially in those cases with a favorable skeletal pattern where the basal arch widths were greater than the coronal arch widths.

Expansion in the deciduous and early mixed dentition is currently experiencing renewed interest (MCINANEY 1980). There is also wide agreement that stable expansion of the maxillary arch can be accomplished in younger age groups by widening the midpalatal suture (HAAS 1980). Expansion of the dental arches with functional regulators working through muscle forces (FRÄNKEL 1974) is also reported to be stable. Fränkel attributes this stability to adaptive changes in the neuromuscular behavior of the perioral soft tissues.

RIEDEL (1960) AND SHAPIRO (1974) have shown that intercuspid and intermolar widths tend to decrease during facial maturation in the postretention period, especially if expanded during treatment. Treatment results and stability of arch expansion in the deciduous dentition must be related to the changes that occur in the dentition of untreated persons, since tooth movement that takes place during and after orthodontic therapy is also influenced by the growth and development of the individual. These influences will affect the developing dentition regardless of whether or not the individual has had previous orthodontic treatment.

MOORREES (1959) AND SILLMAN (1964) report that a moderate increase in width of the dental arches can be expected from the deciduous dentition stage until the permanent cuspids erupt, particularly in the anterior regions. This natural increase in dental arch width must be subtracted from the total measured amount of therapeutic expansion, with only the remainder regarded as an orthodontic widening effect.

The purpose of this study was to shed some light on the question of whether expansion of the dental arches accomplished very early in the deciduous dentition results in stable arch dimensions after termination of retention.

— Materials and Methods —

Thirteen patients and twelve controls were followed in this serial study. The patients in the active group were treated in three private practices, and the control sample followed in two others. Selection of the individual subjects was based on the following criteria:

1 No penetration of permanent teeth through the gingival tissue
2 Class I deciduous cuspid relation
3 No permanent teeth missing
4 No severe learning disabilities or emotional disorders
5 No major systemic anomalies
6 Height and weight within two standard deviations of the mean for the age
7 More than 3MM intercuspid arch length deficiency in the lower arch

The treated sample included 7 girls and 6 boys with a range of age from 4yrs 1mo to 7yrs at the beginning of the study. The control group was comprised of 10 girls and 2 boys ranging in age from 3yrs 4mo to 5yrs 1mo at the time of the first recordings.

Records taken at annual intervals on all subjects included:

- Study casts trimmed to centric relation
- Facial photographs
- Lateral and frontal cephalometric radiographs.

The patients were followed until the late mixed dentition, with seven annual recordings over a six-year period on most subjects.

Expansion in the treated patients was accomplished with removable appliances in 11 cases and with fixed appliances in the 2 others. Although there was some variation, appliances for expansion and retention were worn by most patients in the treatment group from ages 5 through 9, and in a few cases they were continued even longer. Some were undergoing full fixed appliance therapy at the final observation reported here. There was no orthodontic treatment of any of the control group during the observation period.

The records gathered on these 25 patients over a period of 8 years could easily generate an immense number of measurements, but the observations were limited to just a few points which were presumed to be significant.

Cephalometric Measurements

All cephalometric radiographs were taken with the same cephalostat at the University of California, San Francisco, under standardized conditions. Tracings of lateral and frontal films made on acetate sheet were measured to the nearest 0.5mm or 0.5° by one examiner.

Lateral view (Fig. 1)

Landmarks —

- Nasion (N) — Most anterior point of the naso-frontal suture on the midsagittal plane
- Sella (S) — Center of the image of sella turcica
- Point B — The most posterior point in the anterior mandibular curvature between infradentale and pogonion.

Measurements —

- Angle S–N–B
- The shortest distance (mm) from the most labial point of the most labial lower central incisor crown to line N–B.

P-A (frontal) view (Fig. 2)

Measurements —

- Distance (mm) between the cusp tips of the mandibular permanent cuspids
- Greatest distance (mm) between the buccal outline of the mandibular permanent first bicuspid crowns

All measurements were recorded at the initial visit and at subsequent times closest to each yearly interval.

Dental Cast Measurements

Standardized 2× photographs of the dental casts of the subjects were taken with a fixed camera stand from an occlusal view (Fig. 3). Technical assistance on this phase of the project was obtained from Drs. Sheldon Baumrind and Jeff Wong. The following measurements of the 2× photographs were made to the nearest 0.25mm (0.125mm actual dimension) by one investigator:

- *Arch width* at gingival level between the cuspids, first and second deciduous molars or bicuspids. Values were recorded as the shortest distance at the lingual cervical margins.

- *Arch Perimeter* was recorded as the distance between the distal contact points

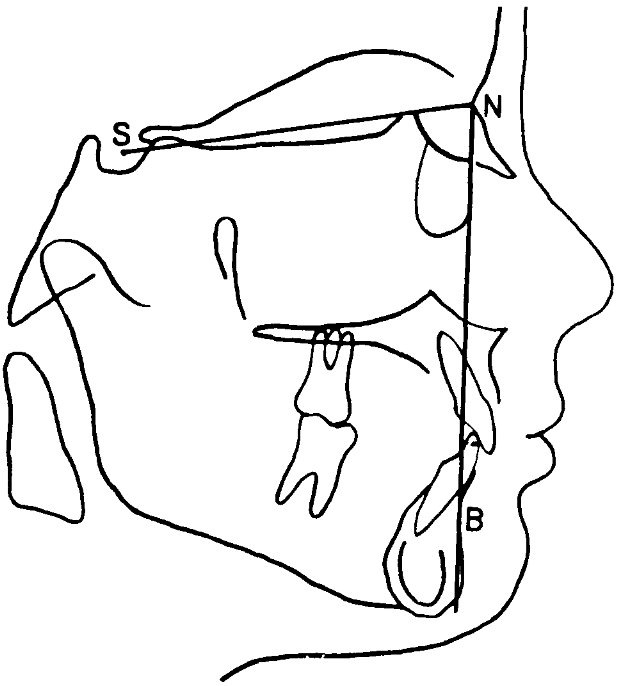

Fig. 1 Lateral cephalometric tracing and landmarks used in this study. S, center of sella turcica; N, nasion; B, most posterior point in the anterior mandibular curvature between infradental and pogonion. The position of the mandible was compared by measuring angle S–N–B. The position of the lower dentition was measured as the horizontal distance from the lower incisor to line N–B.

of the second deciduous molars, measured through the distal contact points of the lateral incisors and mesial contacts of the central incisors, as shown in Fig. 3. If a lateral incisor was not present, severely rotated or ectopically erupted, the mesial contact point of the cuspid was used. In cases where the two central incisors did not contact, a line between the two teeth was bisected and used as a reference point. When only one central incisor was present, its mesial contact point was used. Where the second deciduous molar was replaced by the second bicuspid, arch perimeter was measured from the distal contact point of the second bicuspid.

Measurements were not recorded for teeth that were severely tipped, rotated, ectopically erupted, carious, or in the process of initial eruption or exfoliation. Width measurements were made only between two deciduous or two permanent counterparts, not during a transitional stage where a deciduous tooth was present on one side and a permanent tooth on the other. Some data was also unavailable because patients failed to appear for their annual record appointment.

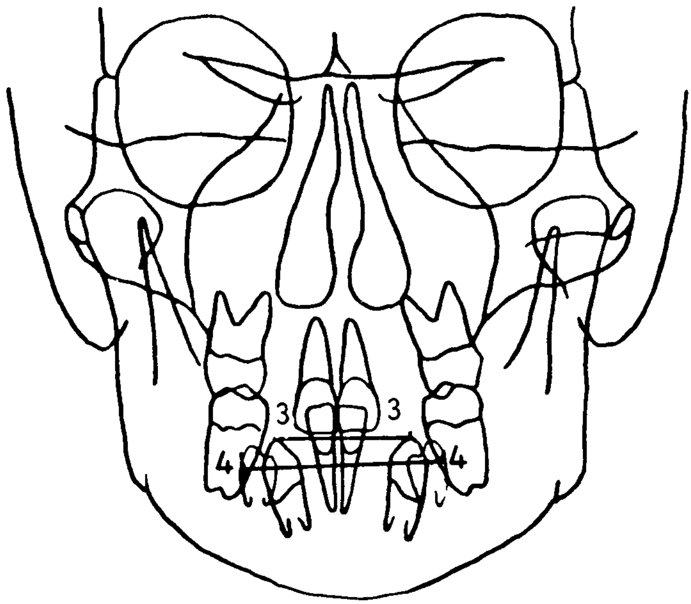

Fig. 2 Frontal cephalometric tracing, showing dental measurements made from the cusp tips of the mandibular permanent cuspids (3-3) and the buccal surfaces of the mandibular permanent bicuspids (4-4) during the process of their development and eruption.

Mean values of the individual cephalometric and cast measurements were calculated and plotted. A statistical significance test between individual cephalometric and cast measurements for the various age groups between the active and control sample was not regarded as being meaningful due to small sample sizes in some of the subgroups.

— Results —

The means of the four cephalometric and eight cast photographic measurements, along with measurements of four individual cases, are presented in Figs. 4-11.

Mean values are plotted for each of the measurements, showing the expanded group values and control group values at each yearly time point. The actual number of cases measured at each point is shown next to that point on the graph. These mean values are based on small numbers, and thus cannot be used with confidence to represent larger populations.

Cephalometric Variables

Lateral Headfilm

S-N-B angle (Fig. 4)

This angle was fairly constant, with a slight tendency to increase in both control and experimental samples. This is in accordance with the decrease of facial convexity with age. There is no obvious change in the S–N–B angle due to expansion of the dental arches, but the mandi-

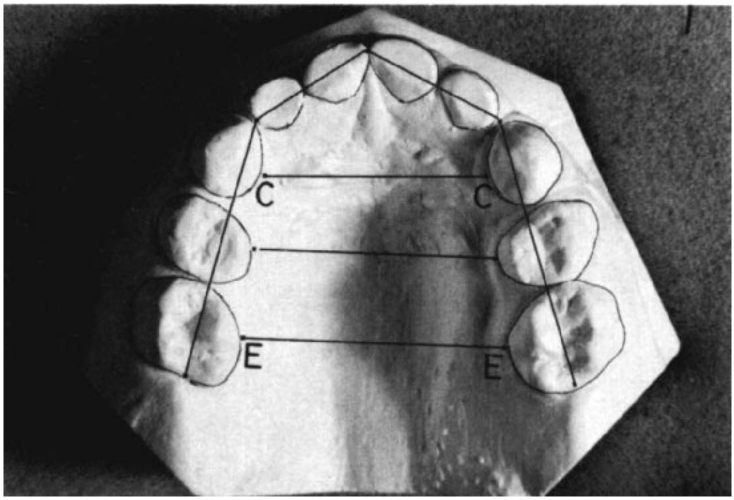

Fig. 3 Standardized dental cast photographs, showing transarch width measurements at deciduous cuspids (C–C) and second deciduous molars (E–E).

The line showing the arch perimeter measurement is also shown.

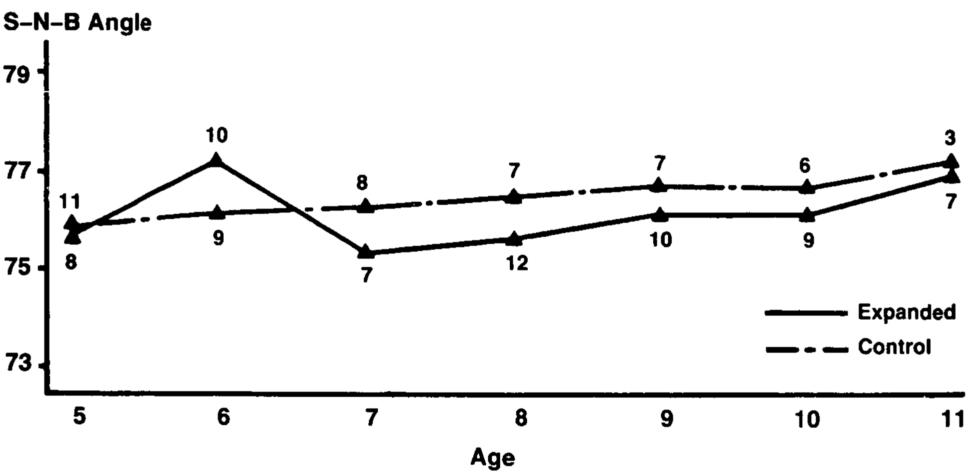

Fig. 4 Mean changes in angle S–N–B from lateral headfilm tracings of the expanded and control groups. A slight increase in the average values represents the more forward position of the mandible seen in both groups. Numbers show the number of cases measured at each age.

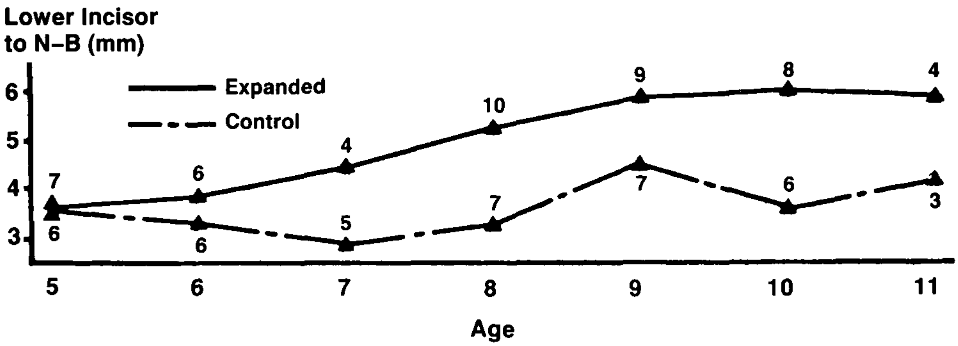

Fig. 5 Mean lower incisor to N-B distance; the increase in the expanded cases indicates some forward positioning of the lower dentition. Numbers show the number of cases measured at each age.

ble does gradually come forward relative to the cranial base in both groups.

Lower Incisor to N-B (Fig. 5)

Although the means at the beginning are similar for the expansion and control samples at 3.7MM, the lower incisors are on the average more procumbent after the active treatment phase. There is a slight increase in both the expanded and control group in lower incisor procumbence with age, but the control group increased to only 4.1MM while the expansion group increased to 5.8mm.

Frontal Headfilm

Lower permanent cuspid width (Fig. 6)

In the control group the lower cuspid width is fairly constant during the observed developmental stages, with the mean changing only from 23.5MM to 23.6MM. Cuspid width in the experimental sample also remains stable in the first three years of the observation period.

Later, with further development of the permanent cuspids, the means of cuspid width in the experimental sample increased from 22.7MM to 28.5MM.

Lower first bicuspid width (Fig. 6)

The mean distance between the lower first bicuspids increases in both groups, but the increase is greater in the expansion group.

Cast Photograph Measurements

Maxillary cuspid width (Fig. 7)

There is a constant increase in maxillary cuspid width in the control group. This can be expected due to transverse maxillary growth. After the widening of the upper arch, the cuspid width in the active group levels off, and there is not much difference between the treatment and control groups.

Maxillary second deciduous molar width (Fig. 7)

There is a steady but small increase in the maxillary second deciduous molar width. After expansion, the second deciduous molar width decreases slightly, but the mean values remain above the control means. It would appear that expansion of this pair of teeth is less prone to relapse, and a net gain in arch width may be achieved, although many of the cases were retained over a long period of time.

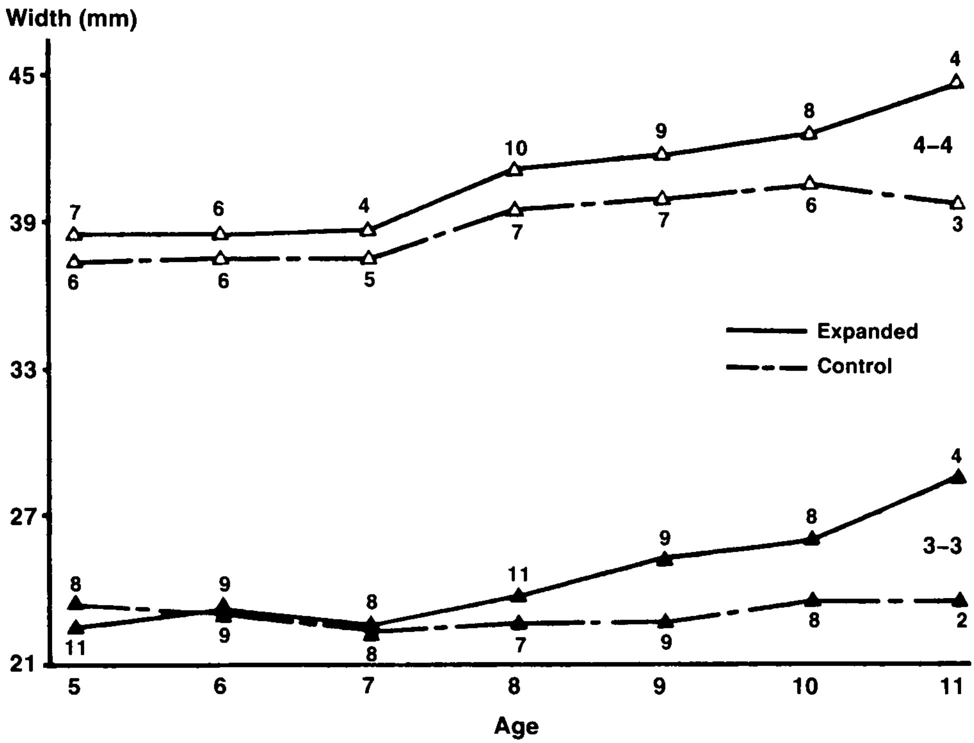

Fig. 6 Mean width at the developing lower permanent cuspids (3-3) and first bicuspids (4-4), measured on frontal headfilms. Little increase is seen in width in the control group, but the expansion group increased in both the cuspid and bicuspid widths. Numbers show the number of cases measured at each age.

Maxillary arch perimeter (Fig. 11)

Maxillary arch perimeter increases with age in both treatment and control groups, in an irregular pattern. The arch perimeter means for both the experimental and control sample decreased in the last observation period, which might be because of the exfoliation of second deciduous molars and the loss of leeway space.

Mandibular cuspid width (Fig. 8)

In the control group, the mandibular cuspid width increased over the entire observation period. Starting from similar baseline values, mandibular cuspid width is increased after expansion to age 8 while the majority of these cases were still in retention. Later, the mean values for those cases which were no longer retained leveled off and the increase in mandibular cuspid width in the control sample eliminated the difference from the expansion group.

Unfortunately, no control measurements were available for the last time interval to confirm this trend, because at that time most of the deciduous lower cuspids exfoliate. According to these

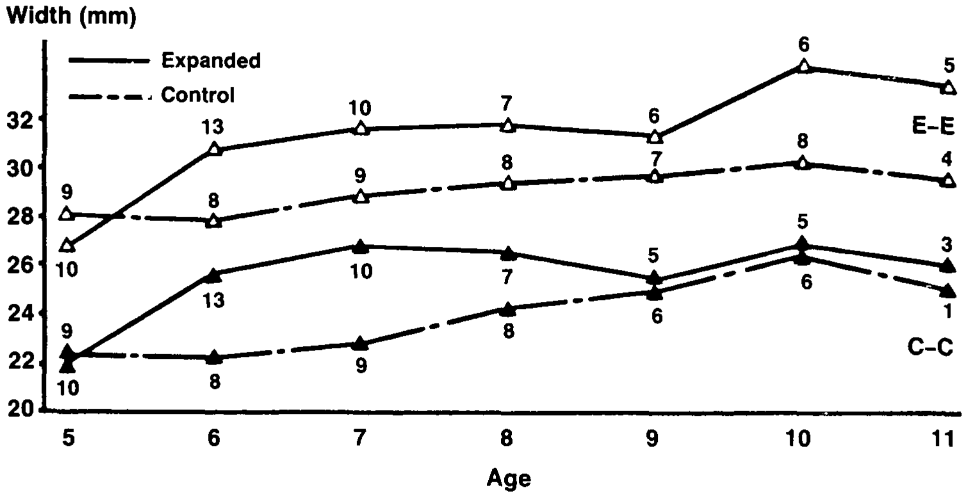

Fig. 7 Average width measurements on the upper dental casts at the deciduous cuspids (C–C) and second molars (E–E). In the expanded cases, the increase in cuspid width (▲) was obtained earlier, but ended about the same as the control group. The width at deciduous second molars (Δ) increased slightly in the control cases, but about 4mm more in the expanded cases. Numbers show the number of cases measured at each age.

numbers, widening of the lower arch between the cuspids, even if performed in the deciduous dentition, has no permanent effect.

Mandibular Second Deciduous Molar Width (Fig. 8)

The lower second deciduous molar width in the control group tended to increase slightly with age, but after similar baseline measurements, the mandibular deciduous molar width in the expansion group was clearly above the control values.

In contrast to the cuspid width, it remained larger for the entire observation period. According to these observations, expansion of the lower first deciduous molars in the deciduous dentition is more stable than cuspid expansion.

Mandibular Arch Perimeter (Fig. 11)

Arch perimeter trends in the mandible were irregular in both the expansion and control groups. As with the maxilla, later decreases are probably related to loss of second deciduous molars.

Individual Cases (Figs. 9 and 10)

All of the preceding data and discussion is based on the average measurements of the expansion and control groups. Because averages tend to level off some changes, Figs. 9 and 10 are included to show the measurements of upper and

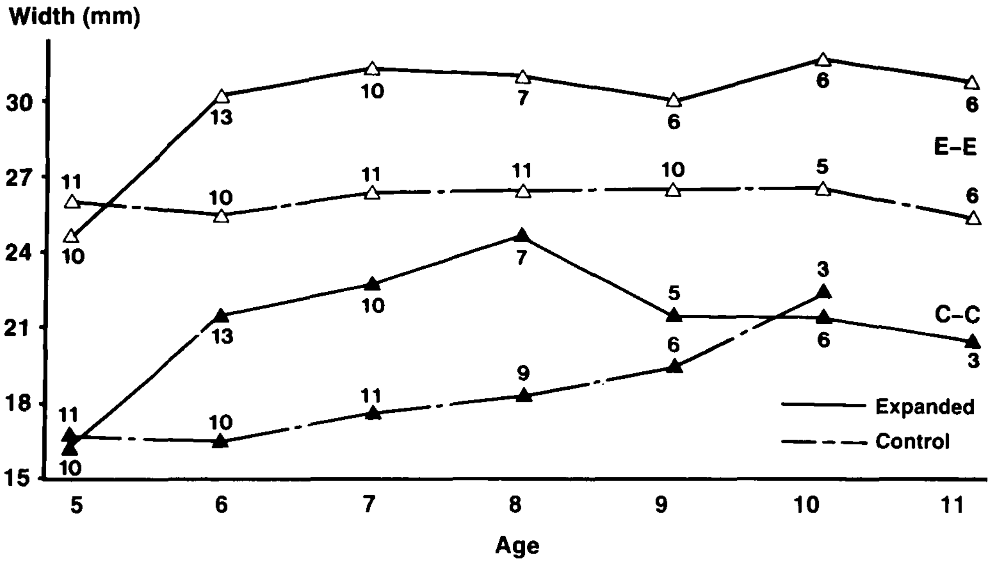

Fig. 8 Average width measurements on the lower dental cast at the deciduous cuspids (C–C) and second molars (E–E). The expanded cases reached a maximum cuspid width (▲) at 8 years and then decreased, while in the control cases, cuspid width increased steadily. The lower second deciduous molar width (Δ) increased in the expansion group and remained wider than the control cases throughout the study. Numbers show the number of cases measured at each age.

lower arch widths for four individuals, two from each group.

Photographic Records

The facial photographs of one of the control patients taken at each annual examination are shown in Fig. 12. The standardized cast photographs for one of the expansion cases are shown in Fig. 13.

— Discussion —

The increases in width in the control sample are similar to the findings of Moorrees (1959) and Sillman (1964) for changes in dental arch dimensions with age. Arch breadth does not change much in the deciduous dentition from the age of 5 to 7 years due to growth alone, but it does increase with emergence of the permanent maxillary and mandibular incisors, especially in the region of the deciduous cuspids. This is effected by appositional bone growth in the mandible and appositional bone growth plus bone growth at the midpalatal suture in the maxilla.

In this study, expansion was initiated at about 5 years of age because it was felt that early widening of the dental arches might positively influence the adaptation of the muscular environment of the den-

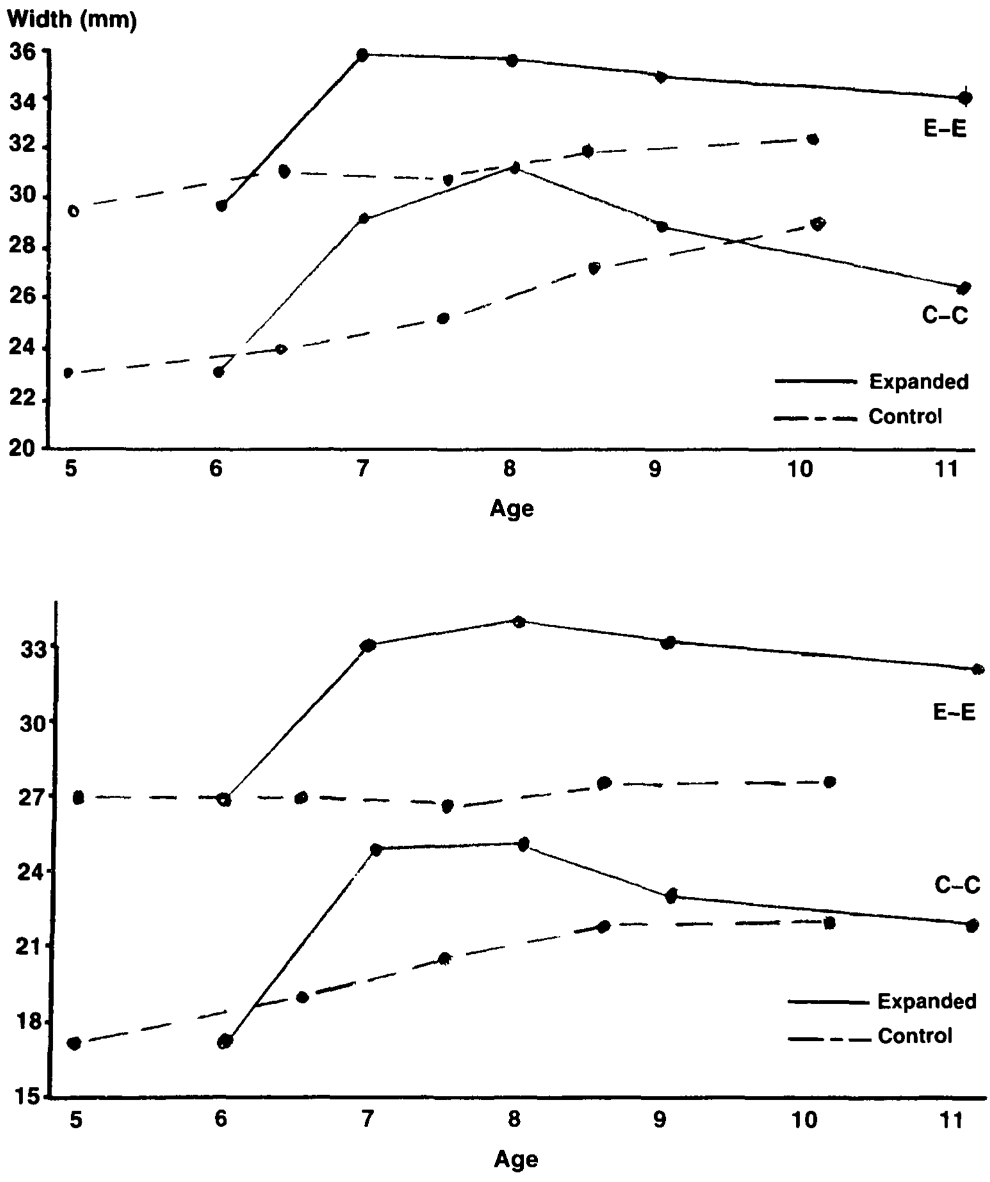

Fig. 9 Upper (top) and lower (bottom) deciduous cuspid (C-C) and molar (E-E) widths in two individual cases. The control case showed steady increases in widths except between lower second deciduous molars. The expansion case showed sharp increases in width with the appliance therapy, followed by a decrease in cuspid width and a slower decrease in molar width.

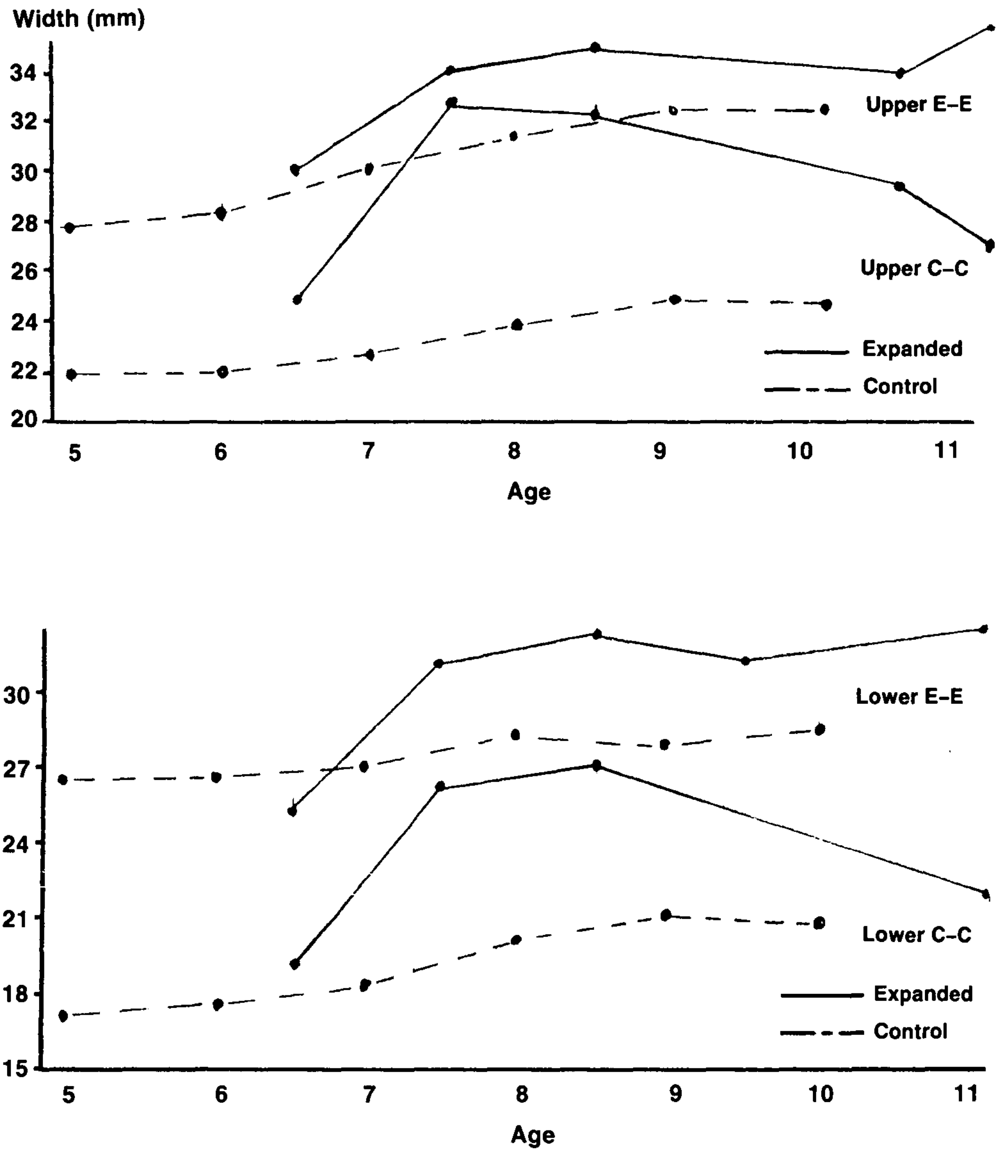

Fig. 10 Upper (top) and lower (bottom) deciduous cuspid (C–C) and molar (E–E) widths in two additional individual cases. The control case showed steady increases in widths. The expansion case showed sharp increases in width with the appliance therapy, followed by decreases in cuspid width and maintenance or slight further increase of molar width.

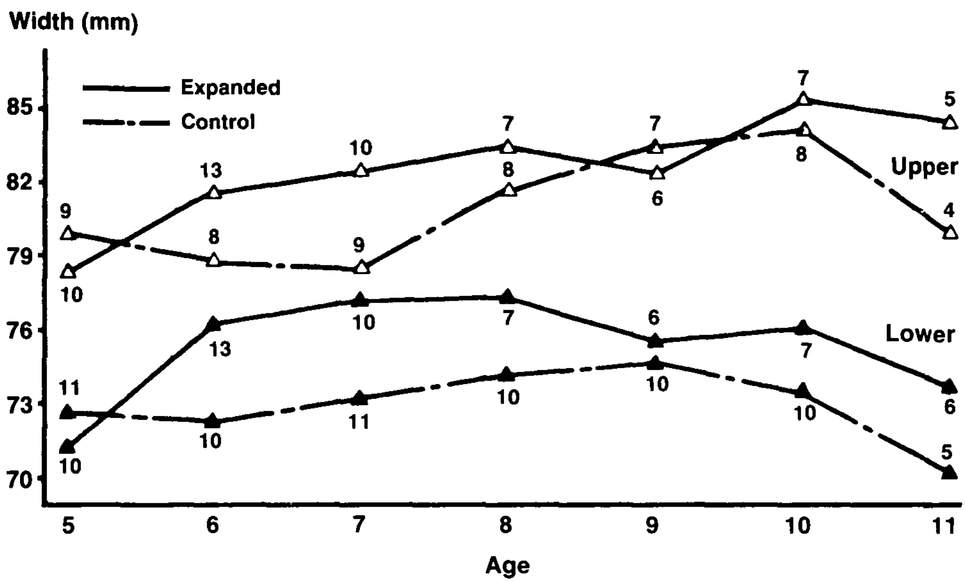

Fig. 11 Maxillary arch perimeter (▲) increased and then decreased to near the original size in both expanded and control groups, although the expanded cases remained slightly larger. In the mandibular arch (Δ) similar trends were seen. Numbers show the number of cases measured at each age.

tition and alter the eruptive paths of the permanent successors in a buccal direction, thus increasing stability.

The active patients were treated in three different offices, so the retention time after expansion differed considerably. Although a long retention time was used to allow better adaptation of the muscular environment to the new wider arch form and a consolidation of the bony and periodontal structures, it also reduced the period available to observe changes in arch width after retention had been terminated.

On average, the expansion cases were actively expanded and retained the first 3 years of the 6-year observation period. Even in the small numbers of cases measured, this was inconsistent; fixed appliance therapy was under way for two of the treatment group at the time of the last observation.

The data on cast measurements suggests that expansion of the second deciduous molars in either arch is prone to some relapse, but the arch width remained above a value expected by natural growth in width by 3.5MM in the upper arch and 5.6MM in the lower arch.

McDougall and McNamara (1982), in their study of arch width development following Fränkel therapy in the mixed dentition, found the largest expansion values compared to their control sample in the deciduous molar or bicuspid and permanent molar areas. They did not find a statistically significant increase in cuspid width in the lower arch.

Fig. 12 Typical facial photos of one of the patients in the control group, showing the maturational changes over a period of 6 years. No orthodontic treatment was done during this time.

Although the age of the patients when treatment was initiated and the mode of treatment differed considerably, it is of interest that the results of this study indicated a similar developmental pattern. Cuspid width after expansion tended to decrease when the retention was terminated, and was then similar to the cuspid width in the control group.

Greater arch width in the deciduous molar area may be of some help in solving an arch length problem, but it is less effective in solving incisor crowding than a gain in cuspid width. The means for the arch perimeter show an increase between the initial and last recordings for both arches in the treatment sample, and the difference between the expansion and control groups is maintained.

Looking at the findings from the lateral headfilms, the anteroposterior position of the mandible as indicated by the S N B angle was not changed by expansion treatment. The lower incisors were, on the average, more procumbent after the active treatment phase; even though expansion was principally directed in the transverse direction, it also had an advancing effect on the lower incisors. This side effect should be considered before initiating expansion as a treatment procedure in cases with procumbent incisors.

The observations from the frontal

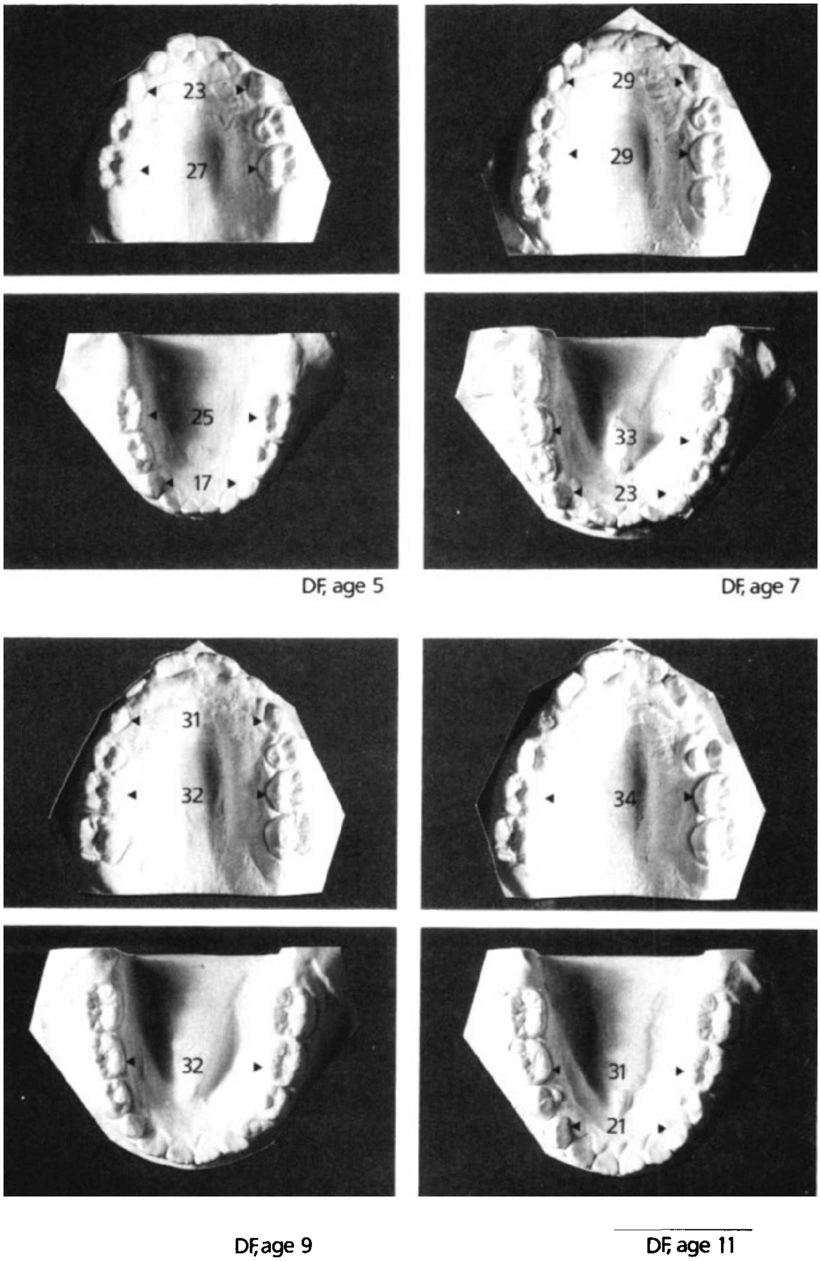

Fig. 13 Dental casts of one of the expanded patients showing measurements made over the six years of observation. In the second set (age 7), the Edgewise appliance can be seen. This type of appliance was used to expand the arch in two of the cases.

headfilms show some very interesting changes. The amount of buccal tipping of the teeth during expansion could not be measured in this study because changes in root morphology during the observation period and superimposition of deciduous teeth on the frontal headfilm made the assessment of tooth inclination unreliable. Therefore, no definite statement regarding the dental width increase being due to tipping or bodily movement of the teeth can be made. However, visual inspection of the crown positions before and after expansion did not give the impression of excessive buccal tipping.

Expansion of the lower deciduous cuspids and first deciduous molars appears to have a minor influence on this developmental phase of their permanent successors. Measurements of lower permanent cuspid width on frontal films (Fig. 6) contrast to the deciduous cuspid measurements on the casts (Fig. 8). The expanded cases were wider by 6MM, which could be an important clinical difference.

The permanent cuspid buds show very little difference between the expansion and control samples through the age of 8, when some appliances had been removed. Then up to age 11, the expanded group showed a progressively greater width increase than the control group. It may be that the muscular environment into which these teeth were erupting had been altered so that it allowed a wider lower cuspid width, but the presence of some appliances makes this unclear.

With the exception of the widths at the upper and lower deciduous cuspids, the data shows that width increases at second deciduous molars, and lower first bicuspids, and upper and lower arch perimeter, were maintained. If this finding could be substantiated in a larger group of cases, the implications for early treatment would be more clear.

The measurements shown here are based on a small number of cases, so the results can be affected by isolated unusual responses. They are also not indicative of a state of equilibrium, since appliances were in place in some cases throughout the observation period. Further study is needed to determine whether patients will generally benefit from this type of expansion treatment.

— Conclusions —

No firm conclusions can be drawn from this study because of the small number of cases which could be measured and the differences in treatment procedures. The data suggests that the following may be expected when dental arches are expanded in crowded cases before the eruption of the permanent dentition:

- The anteroposterior position of the mandible will not be affected.
- The lower incisors will be moved forward on the mandible.
- The path of eruption of the lower cuspids and bicuspids may be altered to provide increased width, particularly with long-term appliance use.
- The upper and lower deciduous cuspid width may be increased while appliances are in place, but will tend to return to the width of untreated cases.
- The upper and lower second deciduous molar width may be increased, and this change may be maintained.
- Upper and lower dental arch perimeter can be increased and held at some gain over untreated cases, even though there is a decrease from ages 8 to 11.

- Further study with more cases which are unretained for longer periods is needed to answer the question of stability of early dental arch expansion.

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