

LONGITUDINAL CHANGES OF DENTAL ARCHES IN GROWING CHILDREN

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Abstract

Dental arch changes are important in the diagnosis, treatment planning and long term stability in dentistry. Our aim was to develop a specific methodology and to train in analyzing the changes on sequential dental casts, in order to initiate a Longitudinal Growth Study. The specific changes and the assessed distances that increased and decreased during different age stages in children that have not been orthodontically influenced demonstrate the tremendous potential of natural growth, development and tooth alignment. In most of the cases lower incisors erupt somewhat lingually and in a slightly irregular position, but have the tendency and start to align very soon. Anterior arch length and depth increases because of the more labial eruption position of the permanent incisors. Posterior arch length usually decreases because of the leeway space, except the eruption of upper permanent canines, when it slightly increases. Intercanine width increases during the eruption of permanent incisors, then can decrease at the beginning of canines eruption and increases later again. The dimensional difference between permanent and primary teeth and the measurement of spaces between primary teeth are important parameters in space analysis at different stages.

Keywords: dentoalveolar natural development, mixed dentition, study casts, mechanical and digital caliper measurements, individual variations

Introduction

Dentoalveolar development is a complex and continuous biological process [1, 2].

Orthodontic treatment represents a cultural influence on the growth and development of the dentition and face [3]. Arch dimensions change with growth; therefore it is necessary to distinguish changes induced by appliance therapy from those that occur as a result of natural growth. Naturally occurring changes in untreated persons should be used as the gold standard for evaluating dental arch changes produced by orthodontic treatment. [4]

The orthodontic records taken to document the patient's initial conditions and to supplement the information gathered from clinical examination, can be divided in three categories: study casts, photographs and

radiographs. Study casts are the only non-invasive three-dimensional records that provide information which is important for orthodontic diagnosis, treatment planning and as medico-legal documents. [5].

The natural development of dental arches has to be considered in orthodontic treatment planning as well as in assessment of stability following orthodontic treatment [1].

Every dentist who provides care for children and adolescents should be able to properly assess and manage their developing occlusions [6]. In planning the management of these patients, the deficit of arch space must be predicted early and the indicated preventive or interceptive procedures instituted [7].

In the cast analysis, the actual value of the individual case is compared with the standard values of the "normal arch" [8].

Graber stated that a balanced, healthy, stable occlusion could be considered normal, even with small tooth rotations and small tooth size-arch length discrepancies [4, 9]. In persons with normal occlusion who have not previously undergone orthodontic treatment, an initial evaluation of adaptive longitudinal changes in the occlusion should be performed. These changes become especially important in growing patients [4]. Based on these initial observations, changes that might occur in the posttreatment period could be determined [4, 10].

Tooth buds lie lingual as well as apical to the primary incisors. The result is a tendency for the mandibular permanent incisors to erupt somewhat lingually and in the slightly irregular position, even in children who have normal dental arches and normal spacing within the arches. In the mandibular arch in both sexes, the amount of space for the mandibular incisors is negative for about 2 years after their eruption meaning that a small amount of crowding in the mandibular arch at this time is normal [11].

The growth process continues throughout life with a smaller rate. The results verified that continuous changes of the dental arches occur from the primary until the adult period, with individual variations, resulting in anterior crowding especially in the mandible and infraposition of the implant-supported crowns [1].

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For determining the variation that occurs in dental arches during development we should have longitudinal dates acquired during long periods of time, which requires a digital database that provide a safe storage [12]. It was verified that there are no major differences between the measurements carried on digital models and that done with a digital caliper on plaster models [12].

The recorded parameters of dental arches, which resulted from longitudinal studies, are presented in tables or graphically in order to illustrate as clear as possible the changes during the observation periods [1, 4, 10, and 14].

Studies that investigated secular changes suggest that average arch dimensions may be smaller in contemporary children than in past generations. The results indicated that arch lengths in both sexes were significantly shorter in the contemporary sample; all arch widths were significantly smaller in contemporary boys, but not in girls [15].

The recorded distances of the dental arches were constantly larger in males compared with those of females [1].

Purpose

The aim of our study is to “make the first steps” in producing actual “normal arch” standards for our population. This means: development of the specific methodology; training in analyzing the changes that occur during growth and development on sequential casts (taken at relatively short age intervals); improvement of own measurement and observation skills; creating an initial database of study casts of untreated children of different ages in order to measure the dimensions at this stages and to initiate a longitudinal study. We will try to keep our sample as large as possible and to take a study cast each year for every included child.

Final goal is a better understanding of growth and prevention of two frequently met aspects: more or less orthodontic treatment then needed at specific stages of dentoalveolar development.

Materials and methods

We started a longitudinal study on 70 children from one school from Timisoara, one nursery school near Timisoara and patients from Paedodontics-Orthodontics Department and one dental practice from Timisoara. The children were selected from those who expressed the acceptance for participating in our Growth and Development Study (including eruption, dentoalveolar and occlusal development and facial growth) and their parents gave us a written consent. Only children that have agreed with the impression were included in this part of the study.

The inclusion criteria were: healthy children with late primary dentition or mixed dentition stage that have never been orthodontically treated before. We tried to select the children with less severe visible malocclusion and less primary premature extractions, but we have not strictly respected the last criteria because the sample would be too small and some children that wanted to participate could have the feeling of discrimination. The group of casts of

each child is individually measured and judged. The children were in late primary (from 5 to 6 years), transitional (from 6 to 8 years and from 10 to 12 years) or intermediate mixed dentition (from 8 to 10 years) stage. We wanted to assess dental arch changes during the intermediate stage as well and we considered that for all this children the second transitional stage will follow.

They were not selected and included at one moment of time, but during one year and a half. That is why some children have one study cast; some have two or three casts.

Cast measurements were made by two trained operators using a mechanic caliper and a digital caliper (Fig. 1).

The mechanic caliper had an accuracy of 0.1 mm and the digital caliper had an accuracy of 0.01mm. The mechanic caliper had an improved design which permitted a better positioning of the free ends at interdental spaces. The final accuracy considered in our study was of 0.1 mm.

We measured the following distances on each study cast: tooth width and arch length, width and depth. We measured *tooth width* by considering the greatest mesiodistal distance between the contact points of each tooth.

Arch length (perimeter) was determined by adding the length of the posterior arch segments from right and left sides and the length of the anterior arch segments. The *posterior arch length* was measured between the distal surface of the primary second molars or premolars and the mesial surface of primary or permanent canines on the right or left sides.

The *anterior length* represents the distance between the mesial surface of primary or permanent canine and the midline of the dental arch added from both sides.

Arch width was obtained by measuring the distance between the corresponding teeth of right and left sides at different levels: *intercanine width* was measured as the distance between the crown tips of the canines (Fig.1); *interpremolar width* as the distance between the lower most point of the transverse fissure of the first premolars in the *maxilla* and the distance between the facial contact point between first and second premolars in the *mandible*; *intermolar width* between primary molars was determined as the distance between the posterior groove of the transverse fissure of the first deciduous molars in the *maxilla* and between the distobuccal cusp tip of first deciduous molars in the *mandible*; intermolar with between the permanent first molars was measured as the distance between the central fossa of the first permanent molars in the *maxilla* and between the tip of the mesiobuccal cusp of the lower first permanent molars in the *mandible*.

The *depth* of the dental arch was obtained at the midline at different levels by measuring the perpendicular distance from the buccal surface of the central incisors to the distal surface of the canine, to interpremolar width and to distal surface of the first permanent molars (Fig.1)

We compared the dimensions and assessed the changes for each dimension between the successive study casts. All the data were registered on a specific chart.



Fig.1 The measurements of arch depth with mechanical caliper (left) and arch width with digital caliper (right) on three sequential study casts at 7 years 4 months, 7 years 11 months and 9 years 4 months.

Results

Case report 1 We measured two study casts of a girl, taken at 6 years 1 month and 7 years 1 month of age (Fig. 2). Dimensions of the same teeth were the same on both measured casts. *Upper intercanine width* increased with 2.4 mm (from 31.3mm to 33.7mm), *upper intermolar width between the primary first molars* increased with 1.5mm (from 34mm to 35.5mm) and *intermolar width between the second primary molars* also increased with 0.5mm (from 37.6mm to 38.1mm). The *intermolar upper width between the permanent first molars* can be determined only on the second cast (43 mm). *The depth of the upper arch to canine level* decreased with 0.5 mm (because of the initial position of the permanent central incisors). *Lower intercanine width* increased 1mm (from 23.6mm to 24.6mm) and *intermolar*

width between the primary first molars, the primary second molars and the permanent first molars remained unchanged. *The depth of the lower arch to canine level* increased with 1.2 mm (because of the more labial position of the lower incisors). The dimensional difference between an upper permanent central incisor (8.2mm) and an upper primary central incisor (6.5mm) is 1.7mm. The difference for both sides is 3.4mm. Measuring the spaces between primary upper frontal teeth we determined the amount of space (4.7 mm) that is available for the alignment of permanent central and lateral incisors. The primate spaces are of 1.2 and 1.6mm and the other three spaces 0.8mm, 0.5mm and 0.6 mm. At this stage, we have 1.3 mm space excess (the difference between 4.7mm and 3.4mm), that will be necessary when the upper second incisors will erupt.

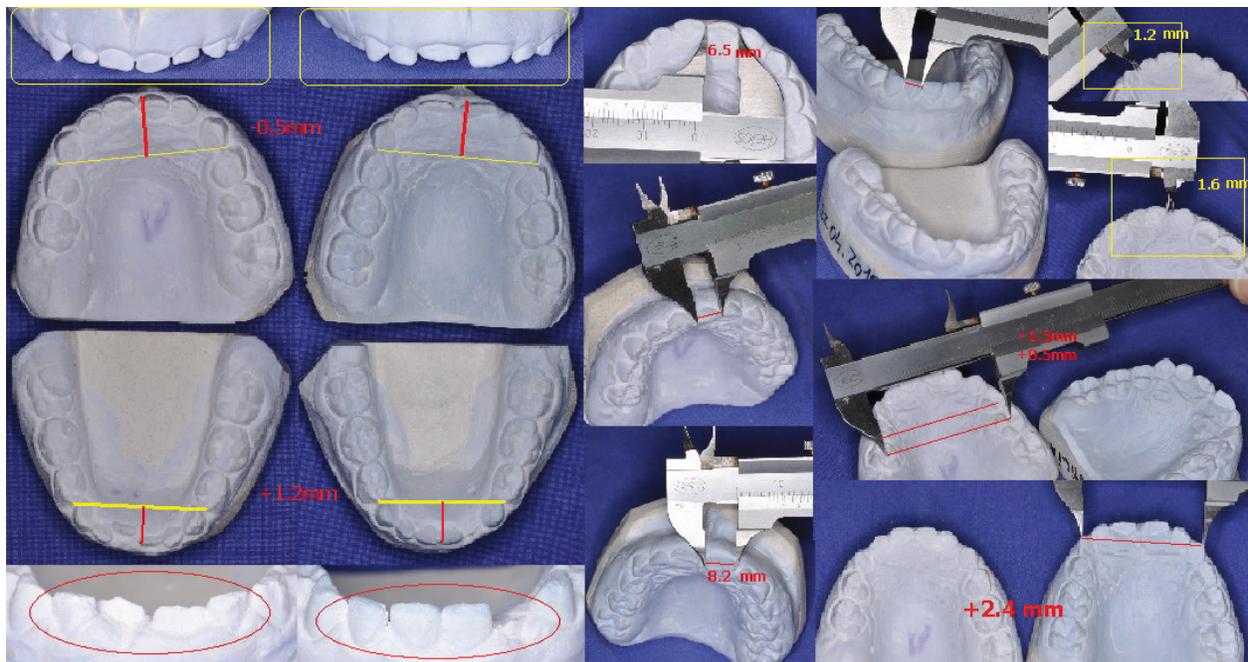


Fig.2 The changes that occur during dental arch development assessed on two study casts (at 6 years 1 month and 7 years 1 month) and the measurements made in order to determine the direction and amount of changes of different diameters

Case Report 2 The study casts of one boy, taken at 6 years 7 months, 7 years 2months and 8 years of age, were measured (Fig.3). *Upper intercanine width* increased with 1.5 mm (from 33.4mm to 34.4mm and then to 34.9),

intermolar width between the primary first molars increased with 0.5mm (from 35.7mm to 36mm and then to 36.3mm) and *intermolar width between the second primary molars* also increased with 1mm (from 39.5mm to 40.1mm and then

to 40.5). The *intermolar upper width between the permanent first molars* remained unchanged. The dimensional difference between an upper permanent lateral incisor (7.5mm) and an upper primary lateral incisor (5 mm) is 2.5mm. The *upper arch depth to canine level* increased 2mm between the last two study casts. The *upper anterior arch length* increased 1.3mm between the second and third study cast (from 31.7mm to 33mm). The sum of the upper four incisors is 33mm (7.5mm the lateral incisors and 9mm the central incisors). The space was enough for the incisor alignment. *Lower intercanine width* increased 1mm (from 25.5mm on both first and second study casts, to 26.5mm on the last study cast) and *intermolar width between the*

primary first molars increased 0.5mm, *the intermolar width between primary second molars and between the permanent first molars* remained unchanged. *The depth of the lower arch to canine level* increased with 1mm (0.5 mm between each of the study casts). The dimensional difference between a lower permanent central incisor (6.5mm) and an upper primary central incisor (5mm) is 1.5mm. The *lower anterior arch length* increased 1.5mm between the first and third study cast (from 23mm to 24mm and then to 24.5mm). The sum of the lower four incisors is 25mm (6.5mm the lateral incisors and 6mm the central incisors). We have a space deficit of 0.5mm. We have 1.3 mm space located posterior to primary lower canines.

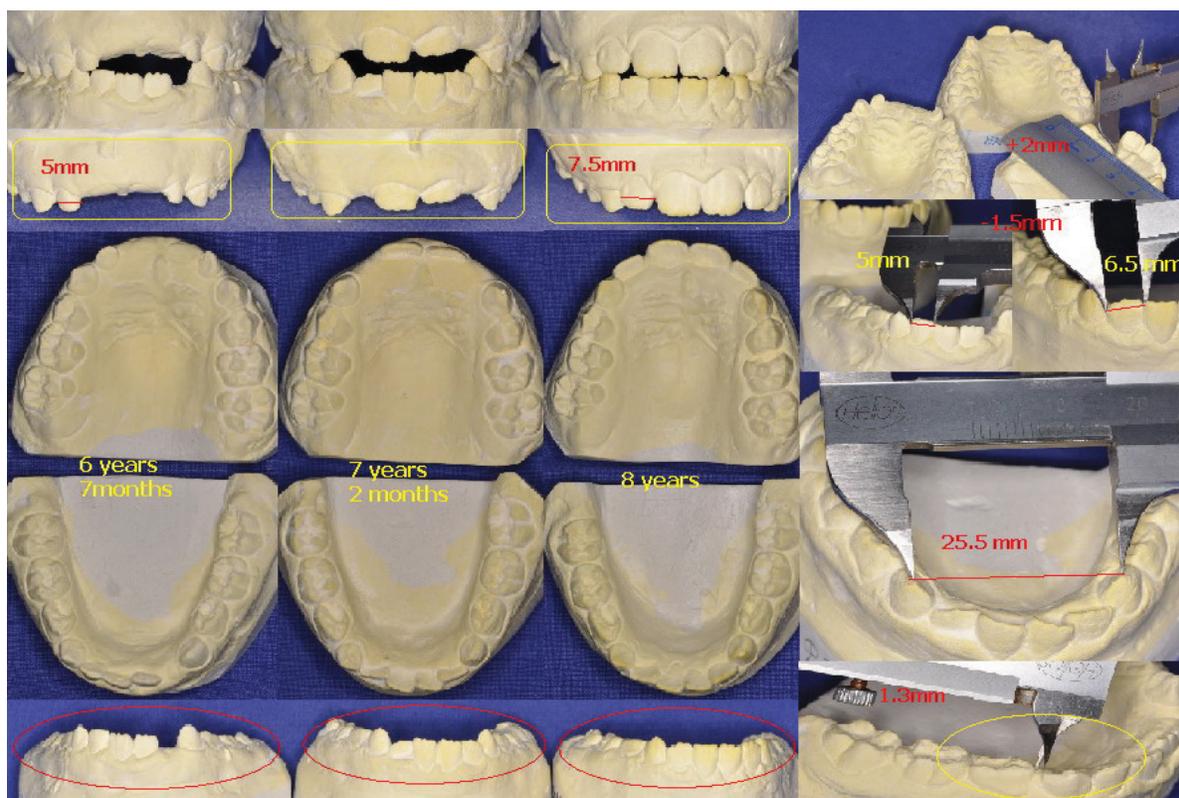


Fig.3 Sequential study casts of one boy at 6 years 7 months, 7 years 2 months and 8 years of age.

Case Report 3 The study casts of a female patient, taken during a period of 2 years (at 10 years 6 months, 11 years 2 months, 11 years 8 months and 12 years 6 months), were analyzed (Fig.4). *Upper intercanine width* decreased in our case between the first two study casts with 2mm (the left canine was pushed palatal), then increased 2.5 mm (during the permanent canine eruption). *The interpremolar width between the first permanent premolars, interpremolar width between the second permanent premolars and the intermolar upper width between the permanent first molars* increased insignificantly. The upper posterior arch length slightly decreased when comparing the first casts and then slightly increased during the eruption of permanent canines (from

21.5mm to 21mm to 21mm to 21.5mm on the right side and from 20.5mm to 20.5mm to 20mm to 21mm on the left side). *The upper arch depth to canine level and the total arch depth* increased 1.5mm (central incisors are more overlapped and the left central incisor is more labially positioned). *Lower intercanine width* decreased between the first and second study cast with 3.6mm, then increased 1.3mm (during the permanent canine eruption). The changes in *lower interpremolar width* could not be assessed; the *lower intermolar width* remained stable. *The lower posterior arch length* constantly decreased on both right and left sides (from 23mm to 23mm to 22mm to 21.5mm on the right side and from 23.5mm to 23mm to 22.5mm to 22mm on the left

side). The total amount of decrease was 1.5mm on each side. The lower arch depth to canine level increased 1mm

between the last two study casts and the total arch depth decreased with 1.5mm.

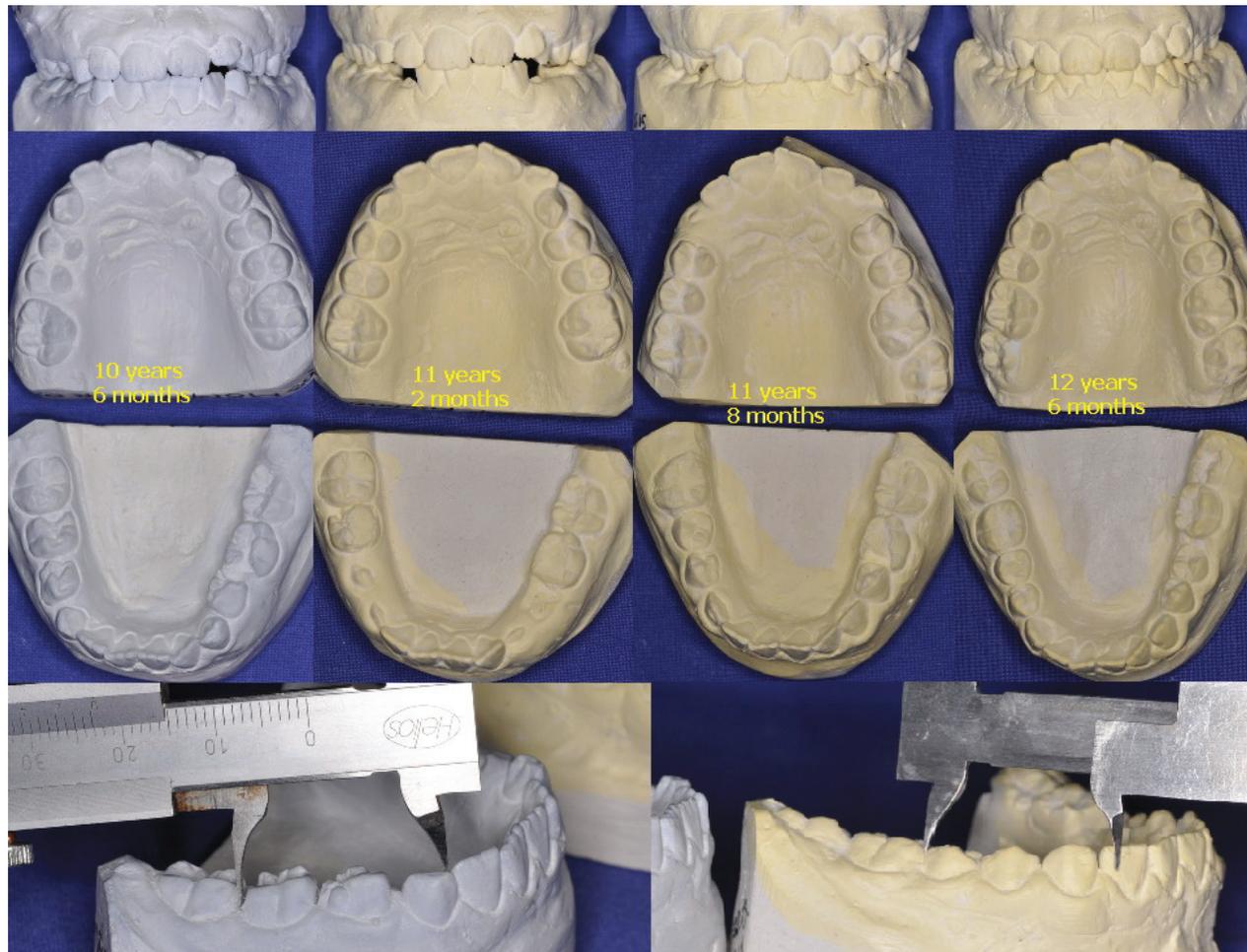


Fig.4 Sequential casts of arch development of one girl, between 10 years 6 months and 12 years 6 months of age.

Discussions and conclusions

Tooth dimensions of the same teeth were identical on all study casts of one patient that means that the dimensional differences between the casts (due to impression and cast manufacturing) were very small.

The upper intercanine width increases between 6 and 8 years, during the eruption of the incisors, because of sutural growth and pushing effect. The other transversal dimensions increase also, but with a slower rate. It can decrease when one canine is pushed palatal (in space discrepancy) and it increases again during permanent tooth eruption. Upper anterior arch length increases during the eruption of permanent central, lateral incisors and canines. Anterior arch depth can slightly decrease during the first eruption stage of permanent upper central incisors, but it will increase soon because of the labial position of the upper incisors. The arch length of the upper posterior segments slightly decreases during the eruption of the premolars, but it will increase during the eruption of the permanent canine. Dimensional primary and permanent tooth measurements and primate

spaces and other spaces measurements are useful for crowding prediction.

The lower intercanine width increases during the incisor eruption (due to the pushing effect) then decreases during first stages of canine eruption. The other transversal dimensions are almost unchanged. Lower anterior arch length and arch depth to canine level increase during incisor eruption and then canine eruption. The lower posterior arch length decreases constantly on both sides during the exchange of primary molars with premolars. The lower permanent first molars will migrate more mesially, establishing the corresponding Angle class.

Crowding depends on the relationship between the size of the teeth and the length, width and depth of the jaws. Any change in dental arch dimension has an influence on this relationship.

The findings of the present study demonstrated significant and important changes in dental arches of contemporary children, over short but dynamic age intervals.

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