A study of growth changes in the mandible from deciduous to permanent dentition

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This cross-sectional study investigated mandibular developmental changes in untreated normal Taiwanese from the deciduous to permanent dentition. Differences in the mean values for ramus height and body length between males and females were statistically significant after eruption of the permanent second molars. SNB angles significantly increased and gonial and L1-MP angles significantly decreased from deciduous to permanent dentition in both sexes. The SN-MP angle in females significantly decreased and ramus inclination in males significantly increased from the early mixed to permanent dentition.

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INTRODUCTION

Numerous investigators[1-8] have described and quantified bodily and facial growth changes at various developmental stages. It is generally accepted that growth of various parts of the body neither proceeds at the same rate nor follows the same patterns. Orthodontists and pediatric dentists are interested in understanding how the face changes from its embryologic form through childhood, adolescence, and adulthood. Of particular interest is understanding where growth occurs and in which directions, and how much growth remains in a person who might need orthodontic or orthopedic treatment. If we had a better understanding of relationships among different parts of the developing skeleton, it would be possible to make more-informed decisions about the timing and type of interventions. Reference data for mandibular growth, which are essential for making diagnoses, allow orthodontists and pediatric dentists to better communicate relevant information and make better treatment plans. Therefore, reference data for untreated Taiwanese subjects are needed. The aims of the present cross-sectional investigation were to provide data on mandibular lateral cephalometric measures and to describe the patterns of mandibular growth.

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MATERIALS AND METHODS

The materials for this investigation were obtained from the files of our department and comprised lateral cephalograms of 297 normal Taiwanese, aged 4 to 30 years. All subjects were determined clinically to have normal angle class I occlusions. None of these subjects had received orthodontic or orthopedic treatment before the radiologic registration. All cephalograms were taken with the teeth in maximum intercuspation, and the head position on the cephalostat was carefully checked to ascertain that the Frankfort plane was set according to the standard. The materials were divided into six groups according to Hellman's dental developmental stages:

(1) Completion of deciduous dentition (IIA stage);
(2) Completion of the permanent first molar eruption (IIIA stage);
(3) Transitional stage of deciduous buccal teeth to permanent buccal teeth (IIIB stage);
(4) Eruption stage of the permanent second molar (IIIC stage);
(5) Completion of the permanent second molar eruption (IVA stage); and
(6) Adult.

The distribution of the sample is presented in Table 1.

All cephalograms were traced on a light box with a sharp 4H pencil on a semi-mat acetate drafting sheet fixed to the film. Fifteen anatomic landmarks were identified on each tracing (Table 2). The tracings were digitized by translating the points on the landmarks onto an X-Y coordinate system. From these landmarks, three linear and seven angular measurements were derived (Figure 1). These measurements included ∠SNB, the

Table 1. The distribution of the sample

	Dental developmental stage IIA	IIIA	IIIB	IIIC	IVA	Adult	Total
Male	11	30	25	24	32	25	147
Female	10	30	25	24	32	29	150
Total	21	60	50	48	64	54	297

Table 2. Cephalometric landmarks

N: Nasion (The most anterior point of the nasofrontal suture)
S: Sella (The center of the cavity outlined by sella turcica)
Me: Menton (The most inferior point on the mandible at the symphysis)
Ar: Articulare (The point of the intersection of the inferior surface of the cranial base and the averaged posterior surfaces of the mandibular condyles)
A: Subspinale (The most concave point on maxillary alveolus)
B: Supramentale (The most concave point on mandibular alveolus)
Pog: Pogonion (The most anterior point on the mandible at the symphysis)
GoL: Lower Gonion (The most inferior point on the mandible at the angle)
GoP: Posterior Gonion (The most posterior point on the mandible at the angle)
D: Point D (The most posterior point on the mandible at the symphysis)
Gn: Gnathion (The most inferior and anterior point on the mandible at symphysis)
Po: Porion (The most superior point on the ear rod)
Or: Orbitale (The most inferior point on the orbit)
L1: Lower incisor edge (The point on the lower incisor edge)
L1R: Lower incisor root apex (The point on the lower incisor root apex)

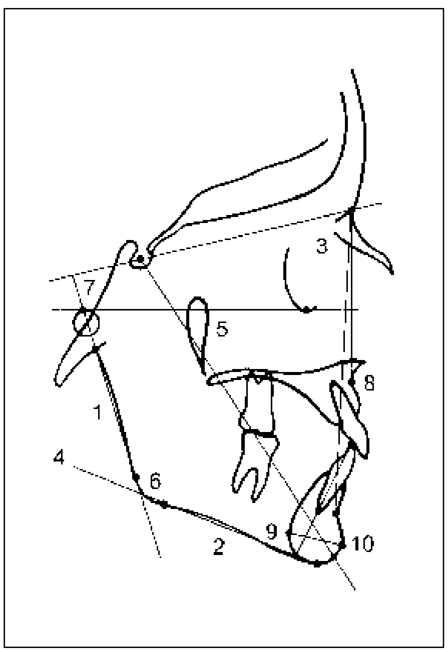

Figure 1. Linear and angular measurements
1: Mandibular ramus height (the distance between Ar and GoP)
2: Mandibular body length (the distance between GoL and Me)
3: ∠SNB (the angle of SN and NB)
4: ∠SN-MP (the angle of SN and GoL-Me)
5: Y-axis (the angle of Po-Or and S-Gn)
6: Gonial angle (the angle of Ar-GoP and GoL-Me)
7: Ramus inclination (the angle of SN and Ar-GoP)
8: ∠ANB (the angle of AN and NB)
9: ∠L1-MP (the angle of L1-L1R and GoL-Me)
10: Symphysis thickness (the distance between Pog and D)

Y-axis, ramus inclination, and ∠MP-SN, which relate mandibular structures to cranial planes. In addition, Ar-GoP, GoL-Me, Pog-D, and gonial angle were used to describe the mandibular ramus height, the mandibular body length, the symphysis thickness, and the shape of the mandibular angle, respectively. ∠ANB was recorded to indicate maxillary/mandibular relationships, and ∠L1-MP was recorded to indicate inclination of the lower incisor. Linear and angular measurements are given in millimeters and degrees, respectively.

Statistical analysis was performed using the Sigmastat statistical software package. Mean values and standard deviations were calculated for each measurement at the six stages of dental development. Differences between the mean values were tested between males and females by means of Student's *t*-test. Analysis of variance (ANOVA) was used for comparison of mean values for each measurement among the six stages. The level of significance used in this study was predetermined at 0.05.

RESULTS

Mean values and standard deviations of each measurement in each stage were plotted, and the resulting developmental curves are presented separately for males and females (Figs. 2-11). No significant differences were present in growth profiles of any of the mandibular parameters between males and females. In all figures, a star, *, indicates that there was a significant difference between males and females; a pound mark, #, indicates that there was a significant difference

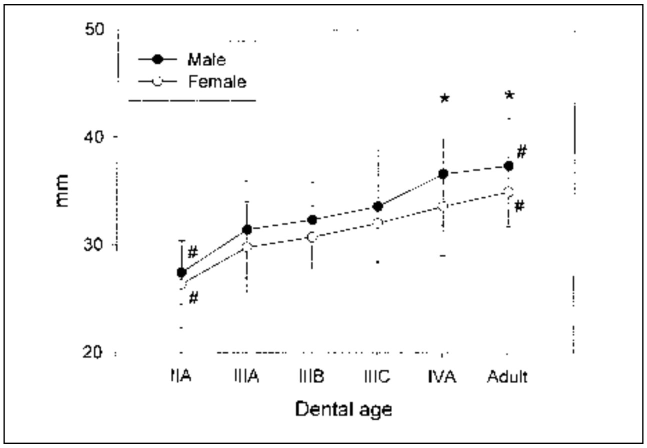

Figure 2. The developmental changes of the mandibular ramus height.

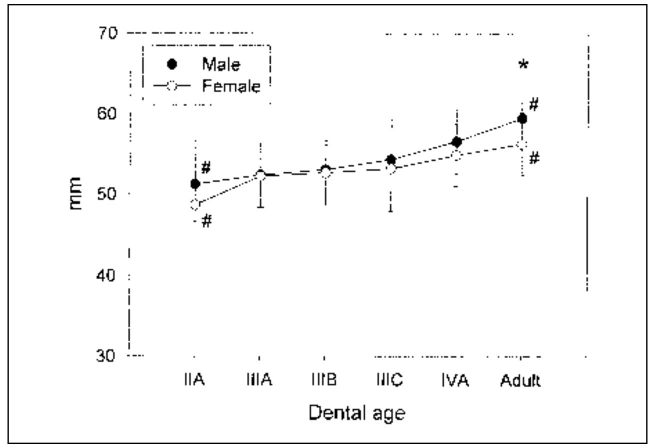

Figure 3. The developmental changes of the mandibular body length.

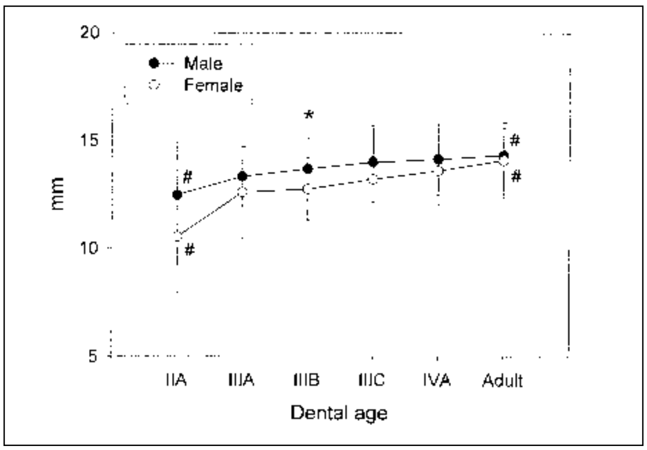

Figure 4. The developmental changes of the mandibular symphysis thickness.

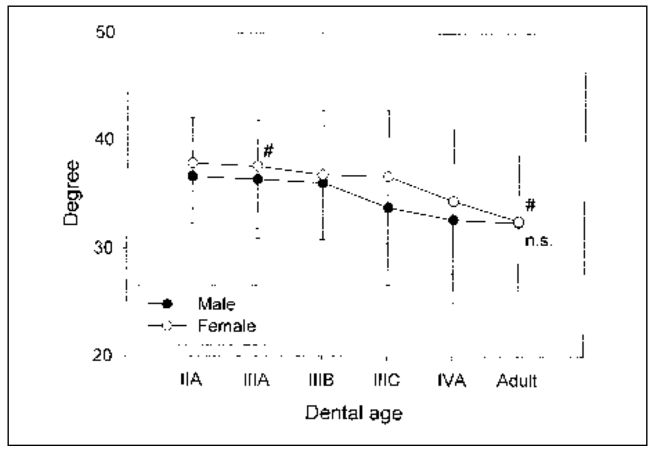

Figure 5. The developmental changes of the angle SN-MP.

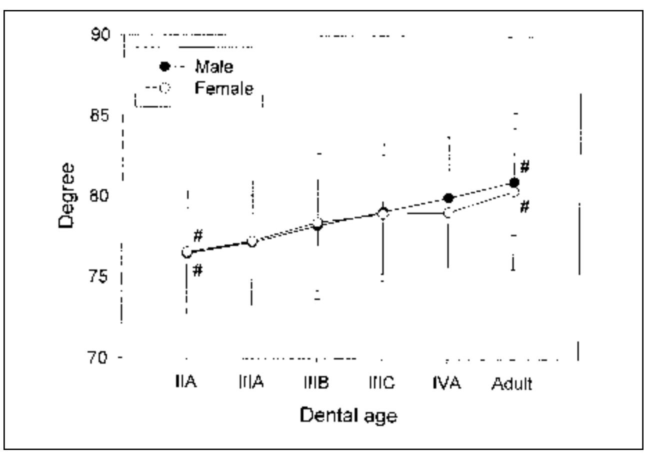

Figure 6. The developmental changes of the angle SNB.

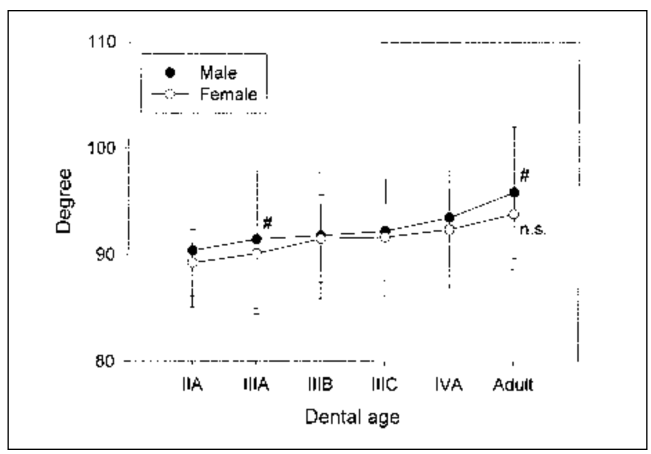

Figure 7. The developmental changes of the ramus inclination.

between the two stages; and n.s. indicates that no significant differences were present in the mean values among the six stages.

Mandibular ramus height

Mandibular ramus height in both sexes significantly increased from the IIA stage to adult. The mean value in males was greater than that in females at each stage. It was significantly greater in males than in females at the IVA and adult stages of development.

Mandibular body length

The mandibular body length in both sexes significantly increased from the IIA stage to adult. The mean

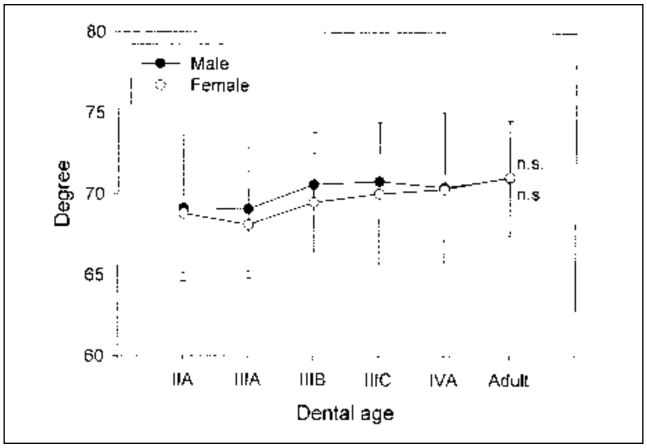

Figure 8. The developmental changes of the Y-axis.

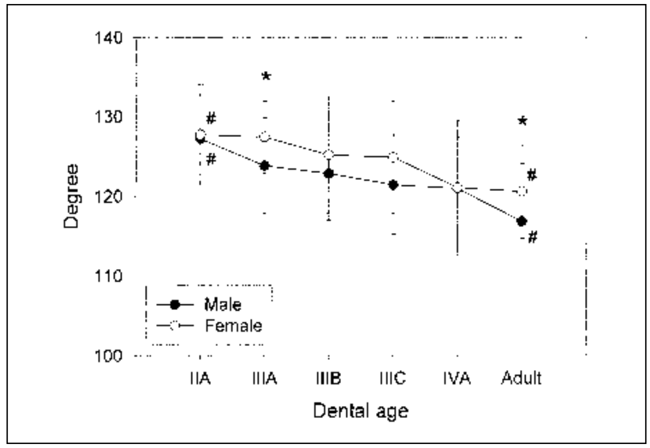

Figure 9. The developmental changes of the gonial angle.

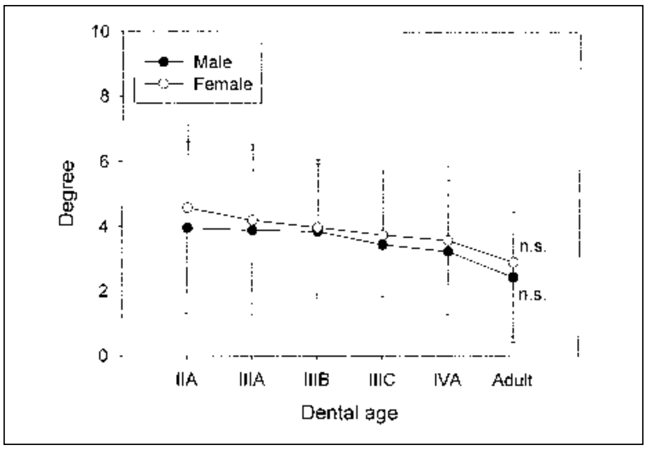

Figure 10. The developmental changes of the angle ANB.

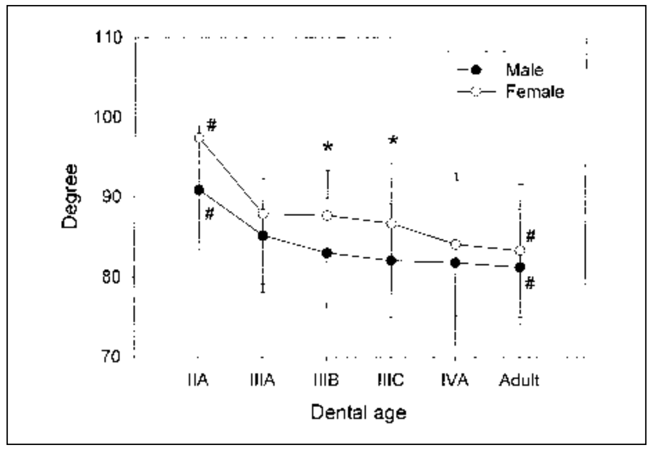

Figure 11. The developmental changes of the angle L1-MP.

value in males was greater than that in females at each stage. It was significantly greater in males than in females at the adult stage of development.

Symphysis thickness

Symphysis thickness significantly increased in both sexes from the IIA stage to adult. The mean value in males was greater than that in females at each stage. It was significantly greater in males than in females at the IIIB stage of development.

Angle of SN-MP

The angle of SN-MP did not significantly differ between males and females at any of the six stages evaluated. The total changes in males did not significantly differ between stages. However, the mean values in females significantly decreased from the IIIA stage to adult.

Angle of SNB

The angles of SNB in both sexes significantly increased from the IIA stage to adult and the IIIA stage to adult, respectively. No significant differences were present between males and females at any of the six stages evaluated.

Ramus inclination

No significant differences were present in ramus inclination between males and females at any of the six stages evaluated. Total changes in females did not significantly differ between the stages. However, mean values in males significantly increased from the IIIA stage to adult.

Y-axis

No significant differences were present in the Y-axis between males and females at any of the six stages evaluated. Total changes in both sexes did not significantly differ between the stages.

Gonial angle

Gonial angle in both sexes significantly decreased from the IIA stage to adult. The mean value in females was greater than that in males at each stage. It was significantly greater in females than in males at the IIIB and adult stages of development.

Angle of ANB

There were no significant differences in comparisons of maxillary/mandibular relationships between males and females at the six stages of development. Total changes in both sexes did not significantly differ between the stages.

Angle of L1-MP

The angle of L1-MP in both sexes significantly decreased from the IIA stage to adult. The mean value in females was greater than that in males at each stage. The ANB angles in females at the IIIB and IIIC stages were larger than those in males.

DISCUSSION

Orthodontists and pediatric dentists are interested in learning about the growth of the various parts of the face, not only where growth occurs but also when it occurs or ceases to occur. Traditionally, the emphasis has been on periods of maximum growth changes, i.e., the adolescent years. More recently, the number of adults undergoing orthodontic treatment has increased significantly,[9-12] and so it has become important to evaluate the changes that occur in the face during later periods of growth as well. Successful orthodontic treatment in growing patients may depend heavily on the amount and direction of jaw growth. Lateral cephalograms[13-16] are indispensable tools in orthodontic diagnosis, treatment planning, and the quantification of dentofacial changes over time. In this study lateral cephalograms were used to investigate growth of the mandible from the deciduous to permanent dentition.

In the analysis of growth curves, two aspects were evaluated: the shape or profile of the curves and the magnitude of the curves to be compared.[17] The shape or profile of a curve is the slope that describes the growth direction. In this respect, the curves might show a parallel relationship, indicating that the growth trends are the same. On the other hand, a lack of parallelism among curve profiles indicates differences in growth trends. The magnitude of the curves is the height of the curves with age held constant; it describes the amount of change. Cross-sectional comparisons of growth profiles in this study indicate that growth trends of the three linear measurements were essentially similar between males and females. The findings of this study also indicate that the mandibular ramus height and body length demonstrated a progressive increase in absolute dimensions during the observation period, and that greater increases occurred during eruption of the permanent first and second molars. Changes still occurred in other periods of growth, but they were essentially of smaller magnitude. The mandibular ramus height and body length did not significantly differ between males and females at the earlier stages of development. However, differences were significant at the later stage of development (after the eruption of the permanent second molars).

Although the predominant trend of mandibular growth is superior and posterior, simultaneous displacement of the entire jaw in an opposite course occurred, and muscular attachments are also responsible for the development of various bony areas such as the gonial regions. From the findings of changes in the Y-axis, SNB angle, and ANB angle, it is clear that the mandible descends downward and forward keeping constant relationships with the cranial base and maxilla, in both sexes. There was a significant reduction in the gonial angle over the total period of observation in both males and females. However, differences between males and females were seen in changes of the SN-MP angle and ramus inclination; females' SN-MP angle decreased and males' ramus inclination increased with growth. Because the mandibles of males and females grow in the same direction, differences between the sexes in the two angles may be due to changes in the shape of the gonion. This suggests that there is more bone deposition on the posterior border than at the lower border of the gonion in males; however, there is more bone deposition on the lower border than the posterior border of the gonion in females. The decrease in the L1-MP angle during the observation period in both sexes might have been due to changes caused by growth of the mandible with the lower incisors tip to the lingual side compensating for forward growth of the mandible.

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