A Longitudinal Growth Study: Maxillary Length at Puberty in Females

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Growth and development of the middle face has been investigated by many. These studies investigated: the remodeling changes which occurred during the postnatal growth of the maxilla and its forward and downward displacement,[2,4,5,10] the role of the cartilaginous nasal septum in midfacial growth,[1,8,9,12] the effects of cleft lip and/or palate on maxillary growth,[6] and the effects of orthodontic and orthopedic forces on maxillary growth. Singh and Savara[15] and Björk[2] made the only cephalometric longitudinal investigations considered in this study to report on amount, timing, and rate of maxillary growth during puberty.

This investigation was carried to:

1. Demonstrate the individual variability in the timing of the peak velocity for maxillary length.
2. Determine whether menarche, onset of epiphyseal-diaphyseal fusion, and peak velocity occurred prior to or after the peak velocity for maxillary length.
3. Determine whether the absolute size of the maxilla at peak dictated the magnitude of growth at peak and the duration of the growth spurt.
4. Determine whether the amount of growth after menarche was significantly different from the amount before it.

MATERIALS AND METHODS

The serial lateral cephalometric roentgenograms used in this study were obtained from the files of the Bolton Study at Case Western Reserve University.

The sample consisted of 20 Caucasian females for whom records were taken yearly and is identical to that of a previous article.

The sample was selected to meet the following criteria: a) availability of chronological age at menarche, b) availability of serial cephalometric records three years before and three years after menarche, c) absence of severe skeletal types, d) absence of missing teeth (extracted or congenitally missing) and e) availability of serial hand-wrist films for skeletal age assessment. Twenty percent of the lateral cephalometric radiographs were traced twice by two investigators. The results of the intrajudge and interjudge differences (t-values) were not significant ($P < 0.05$).

Maxillary length was measured as the linear distance between posterior nasal spine and anterior nasal spine.

Measurements were made to the nearest 0.5 of a millimeter. Posterior nasal spine was located by superimposing the total series of radiographs on the DeCoster line and dropping a line through two points, one through the center of the uppermost portion of PTM, and the other through the center of its lowermost point. This method avoided inaccuracy in location.

Reproducibility of measurements was checked by having two sets of measurements made at different intervals. The mean difference and standard deviation of the difference were computed. The "t" test (0.40) revealed no significant differences between the two independent measurements. The data were analyzed graphically by means of incremental growth curves with changes recorded in 0.5 of a millimeter and timing in

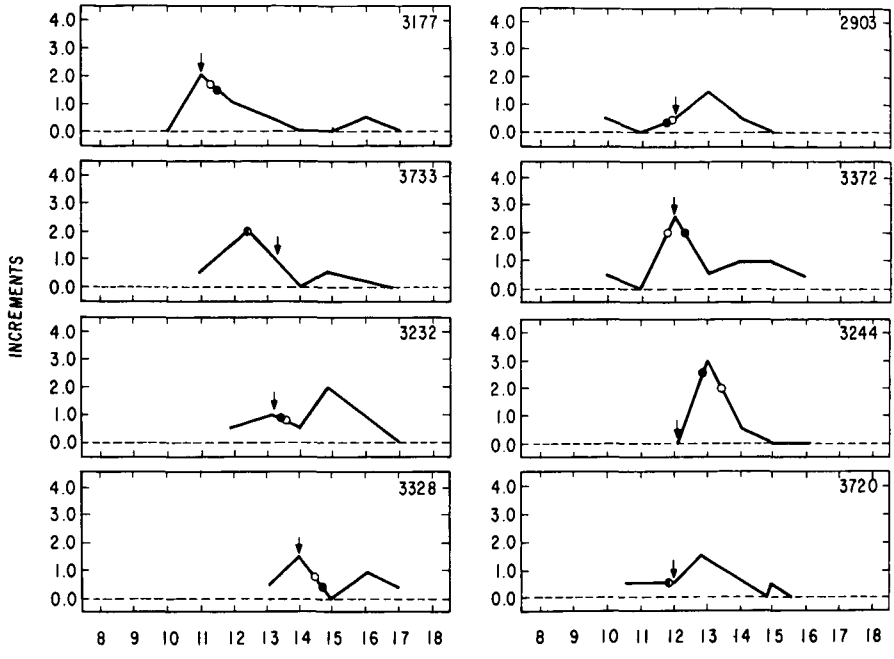

Fig. 1 Curves of absolute growth increments in maxillary length (ANS-PNS) for 8 of 20 females. Arrows indicate the age of maximum increment in standing height; open circles indicate menarcheal age and closed circles indicate onset of epiphyseal-diaphyseal fusion.

chronological age. Menarche, onset of epiphyseal-diaphyseal fusion, and spurt in height were identified in each one of these curves by a circle, a closed circle, and an arrow, respectively.

Mean curves were also plotted by dividing the total sample into groups according to age at the maximum pubertal growth spurt increment. This method avoided loss of individual variability which would have occurred if a single curve had been utilized.[13] For a detailed description of this procedure refer to a prior publication.

Statistically, an analysis of variance for repeated measurements was performed.

Findings

Growth of the maxilla in length changes significantly after menarche ($t = 12.83$, $p < 0.01$). However, there was no significant difference in the amount of growth increment before and after menarche ($t = 0.75$ which is not statistically significant).

The timing of the maximum increment of growth for maxillary length ranged from 11 to 15 years. In 35% it occurred at age 12, in 30% at 13, in 10% at 14 and in 15% at 15. The smallest amount of growth at peak was 1.5 mm, and the largest 3.0 mm. Duration of the spurt was from 2.0 to 3 years. (Fig. 1).

Variability was the rule but the following trends were observed:

1. The higher the peak, the shorter the duration of the spurt.

2. Menarche, onset of epiphyseal-diaphyseal fusion, and peak height velocity occurred before, as well as after, the maximum increment in maxillary length.

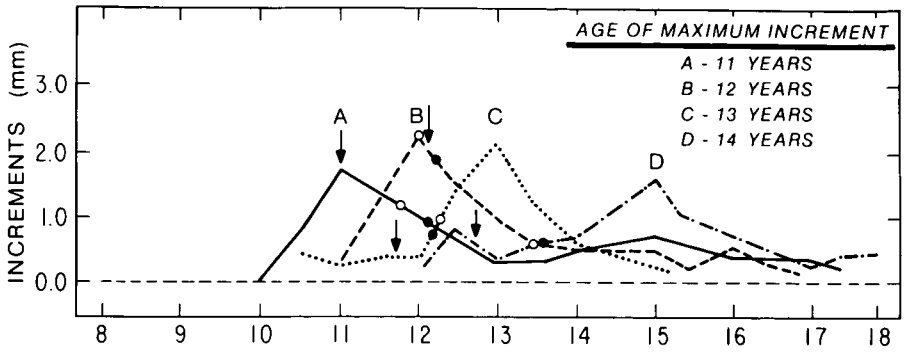

Fig. 2 Annual increments in maxillary length of 4 groups of females with different periods of maximum growth. Arrows indicate the age of maximum increment in standing height; open circles indicate menarcheal age and closed circles indicate onset of epiphyseal-diaphyseal fusion.

In the two females whose age at peak was 11 (Group A), menarche and onset of epiphyseal-diaphyseal fusion occurred after the peak (9 months and 13 months, respectively). Peak of height occurred simultaneously with peak of maxillary growth in the 12 year old group. Menarche, onset of fusion, and peak of height occurred at peak or 2 months after it. The average amount of growth was 2.2 mm at peak acceleration.

For the three girls in whom the peak of growth occurred at 15, menarche, onset of fusion, and height maximum increase occurred prior to the peak of maxillary growth. The amount at peak was 1.5 mm, less than in the other groups.

In summary, menarche occurred after the peak of growth in Group A and coincided with peak in Group B whose maximum increment at peak was 11 and 12, respectively. In groups C and D, whose maximum increment occurred at the 13 and 14 ages, respectively, menarche occurred before peak of growth (Fig. 2).

The early maturing individuals showed larger increments than the late maturing. The average amount of growth was less than 1.0 mm before menarche and 1.0 mm after it, whereas the amount of peak was 1.2 mm.

Timing of maximum increment in maxillary length demonstrated a weak correlation with onset of fusion in the distal phalanges and peak of growth in standing height (r's being .046 and .036, respectively). The absolute size of the maxilla at peak did not dictate the magnitude of growth at peak velocity. There was no significant difference between the two groups (small increments versus large increments at peak velocity) (Fig. 3).

The duration of the spurt was not related to either the absolute size of the maxilla at peak nor to its timing ($t = 0.3942$).

Conclusions

1. A great individual variability is present in the timing of the maximum increment in ANS-PNS.

2. The maximum increment in maxillary length occurred before, as well as after, menarche, onset of epiphyseal-diaphyseal fusion, and peak of growth in height.

3. The later the maximum increment of growth occurred, the earlier menarche and onset of fusion occurred in relation to the peak.

4. The amount of growth at peak

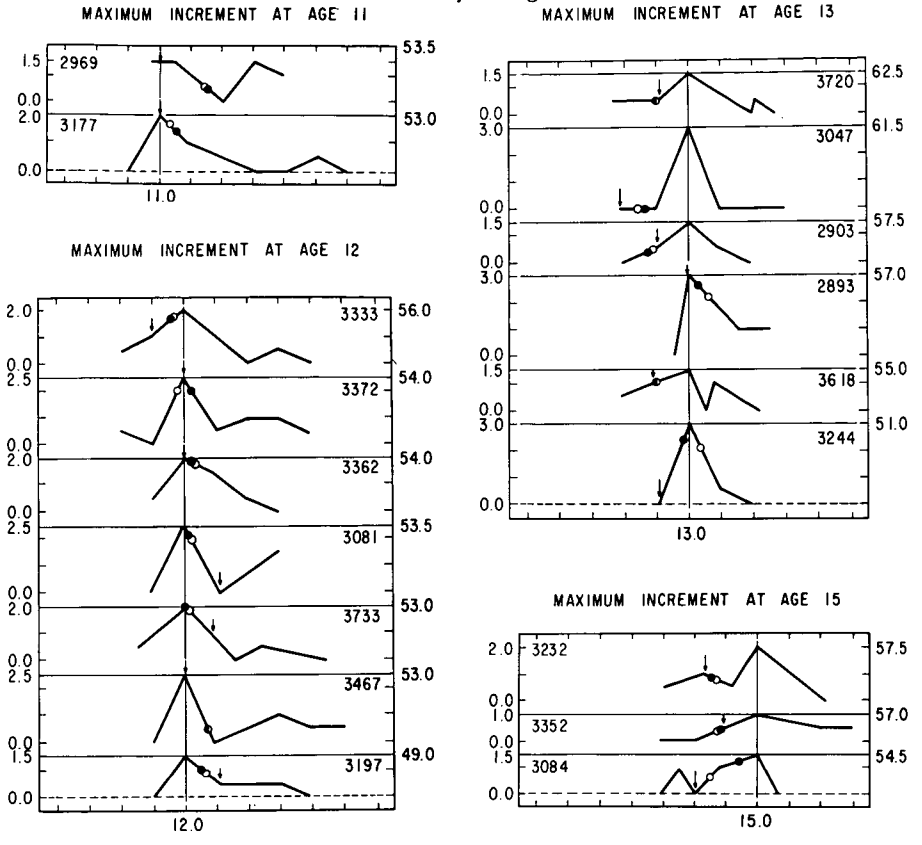

Fig. 3 Annual increments in maxillary lengths (ANS-PNS) arranged so that maximum increments are on the same vertical line. The absolute growth increment at peaks is indicated on the left side and the absolute size at pak on the right side.

and duration of growth were not dictated by the absolute size of the maxilla at peak.

5. There was no significant difference in the amount of growth of maxillary length before or after menarche.

6. Timing of maximum increment in maxillary length was weakly correlated with onset of epiphyseal-diaphyseal fusion and menarche.

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