Distance M-Me: A Novel Parameter having Significant Potential as a Predictor of Mandibular Growth

Abstract

Objectives: The purpose of the present study was to investigate the relationship of the measured distance between two mandibular points (distance M-Me) to chronological age and to find out whether the absolute values of distance M-Me could be classified age-wise into a unique range, which could be directly read for predicting the stage of mandibular growth. Methods and Materials: The study sample consists of lateral cephalometric records of 65 patients (34 females and 31 males; age range: 6–21 years). Chronological age was calculated in decimal years. Lateral cephalograms were assessed by two independent examiners. Points M and Me were located on the lateral cephalograms, and linear distance between them was measured. Results: Pearson product-moment correlation coefficients showed a high correlation between chronological age and distance M-Me (0.746 for females and 0.869 for males, p < 0.01). When the values of distance M-Me were compared with chronological age, it was possible to make four age groups (for females and males separately), where each group showed a unique range of value for distance M-Me. The values increased with increasing age. Conclusions: Increase in value of distance M-Me with age, showing reduced individual variation, depicts a well-conserved linear dimension. Values of distance M-Me can be directly read for predicting the stage of mandibular growth and can be used as a valuable adjunct or substitute to chronological age.

Keywords: Chronological age, mandibular growth, parameter

Introduction

The amazing thing about growth is that it is not mysterious. If we understand growth, then in the early years of development of a child, we can take advantage of growth when necessary or try to minimize growth when undesirable. These growth modification procedures should be in harmony with the innate potential of growth and the effect of systemic and environmental influences. When harmonious attempts are made to modify growth, it will lead to favorable response to treatment with the least potential morbidity.[1]

For effectively timing the growth modification procedure, assessing the stage of skeletal maturity and determining the amount of growth remaining are of paramount importance. As said by Baccetti et al.,[1] for therapies whose basic principle is modification of mandibular growth, treatment timing should include the pubertal growth spurt period when peak in mandibular growth is seen. This is because, effectiveness of treatment strongly depends on the biological responsiveness of the condylar cartilage, which in turn is related to the growth rate of the mandible.[2]

For prediction of skeletal maturity, several biologic indicators have been proposed. Somatic characters such as increase in body height[3] and menarche or voice changes[4] have limited value because these indicators can be applied only after the serial recording of height or the inception of puberty. Biophysiological development can be better evaluated in terms of progressive maturation of the skeleton, what we commonly call as the skeletal age.[5] Radiologic assessment of skeletal maturation is based on the concept that during growth, every bone undergoes a series of changes which is radiologically visible.[6] The widely followed methods include estimation from hand-wrist radiographs[7,8] and cervical vertebral maturation (CVM).[6,9,10] This principle can be applied for a comprehensive assessment of the growth status and growth potential in a particular child.[1,6] However, when it comes to predicting mandibular growth,

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recent studies have shown that these skeletal parameters are not reliable predictors.\textsuperscript{[11,12]}

Chronologic age has been found to be a better predictor of peak mandibular growth than is skeletal age.\textsuperscript{[11,12]} However, in clinical setting, for some patients, date of birth is not known. In such cases, accurate chronological age cannot be determined.

Mandibular dimensions whose increment in dimension coincides with the skeletal growth period including the pubertal growth spurt can serve as the best predictors of mandibular growth. O’Reilly and Yanniello, Franchi et al., and Mitani and Sato\textsuperscript{[11‑15]} have investigated the relationship of mandibular growth to skeletal maturity. In these studies, though the increments in mandibular dimensions (mandibular length, corpus length, and ramus height) showed good correlation with CVM stages, they showed large individual variation and therefore their absolute values could not be universally specified for each CVM stage.

The authors were of the view that if mandibular dimensions which are least affected by environmental factors are considered, change in their values with age could then be universally applied for determining the stage of growth.

Considering that the chin shows a small amount of postnatal increase in dimension which is basically because of the activity at other sites of growth [Figure 1] and is in itself not an active growth site\textsuperscript{[16,17]} two points on the bony chin were marked [Figure 2]. The purpose of the present study was to investigate the relationship of the measured distance between points M and Me on the bony chin (distance M-Me) to chronological age and to find out whether the absolute values of distance M-Me could be classified age-wise into a unique range, which could be directly read for predicting the stage of mandibular growth.

**Methods and Materials**

The present study was designed as a cross-sectional descriptive study. Before conducting the study, ethical clearance was obtained from the Institutional Ethical Committee.

The sample was derived from lateral cephalometric radiographs of patients who visited the Department of Pediatric Dentistry and Department of Orthodontics of the institution, in between January 2016 and August 2016. Parents of the individuals were informed about the nature of the study, and informed consent was taken before obtaining their lateral cephalograms. The inclusion criteria were: (1) individuals of Indian origin, (2) individuals with no history of systemic disease which can affect general growth and development, and (3) individuals with no history of orthodontic treatment.

Name, age, sex, and date of birth (as in school records) of each individual were noted down on a prepared information sheet. Chronological age of each individual was then calculated in decimal years.

For obtaining lateral cephalograms, the radiographic technique was standardized. They were taken using MyRay’s Hyperion X7 imaging system (manufactured in Italy), and the distance between object and radiation source was fixed at 5 feet. Digital images were saved and image calibration was done to obtain 1:1 magnification. The final images were then developed. Only radiographs which showed high clarity and good contrast were selected. All the cephalometric tracings were done in a darkened room using a transilluminated view box on one side glazed acetate paper of 0.03 inch thickness using a 3H lead pencil.

For the proposed mandibular measurement, tracing of hard tissue outline was done on lateral cephalogram, and the following points were located [Figure 2] – (1) Point M which was marked as the mid-point in the concavity of the mandible (which lies between the most superior point on the alveolar bone overlying the mandibular

![Image](image_url)

**Figure 1:** Principal primary growth centers in late prenatal and early postnatal growth periods; A=midline synchondrosis, B=angular synchondrosis, C-condylar secondary cartilage

![Image](image_url)

**Figure 2:** Lateral cephalogram showing points M and Me. Point M has been marked as the mid-point in the concavity of the mandible, which may or may not coincide with point B—the deepest point in the concavity of the mandible. Menton, lowest point on the symphyseal shadow of the mandible, has been marked as point Me.
incisors [infradentale] and the most anterior point on the chin [Pog]) and (2) Menton (Me) which was identified as the lowest point on the symphyseal shadow of the mandible. Linear distance between points M-Me was measured using a ruler calibrated to 0.5 mm [Figure 3].

The study was divided into two parts: the pilot study for sample size estimation and the main study to investigate the correlation between distance M-Me and chronological age. A statistical power analysis was performed for sample size estimation, based on data from the pilot study (n = 30). The effect size (ES) in this study was 0.83 considered to be large using Cohen’s (1988) criteria. Taking a realistic ES of 0.5 which is known to be medium ES, with alpha = 0.05 and power = 0.80, the projected sample size needed with this ES was approximately n = 29. The sample size of the main study was inflated to 65 (34 females and 31 males; age range: 6–21 years).

Two independent examiners who were blinded to the age and the gender of the individuals carried out the measurement. To test the reproducibility of the assessments, the same lateral cephalometric radiographs were reevaluated by the same two examiners 3 weeks after the first evaluation. The mean of the measurements taken by the two examiners was calculated and subjected to statistical analysis.

**Statistical analysis**

All statistical computations were performed using computer software (SPSS for Windows, release 24.0.0, SPSS Inc., Chicago, III, IL, USA).

Kappa score measurement of agreement beyond chance was used to assess inter- and intra-observer reliability. Pearson product-moment correlation coefficients were estimated to determine the association between chronological age and distance M-Me, and the statistical significance of the correlation was tested. Descriptive statistics were done by determining means and standard deviations of distance M-Me for different age groups for both males and females.

**Results**

The mean of the generalized kappa value for interobserver agreement was 0.85 for distance M-Me. The reproducibility of all the assessments was very good. Intraobserver agreement was substantial with a kappa coefficient value of 0.89 for distance M-Me.

Pearson product-moment correlation coefficients “r” between chronological age and distance M-Me for both females and males are shown in Table 1. A high correlation was found between the two (0.746 for females and 0.869 for males). The correlations were statistically significant at p < 0.01 significance level. Distribution of values of distance M-Me according to age (four age groups could be made when the values were compared to chronological age) are shown in Tables 2 and 3 (for females and males, respectively). The values increased with increasing age.

**Discussion**

In the present study, the relationship of distance M-Me to chronological age was investigated, and the results showed a strong correlation between them. When the values of distance M-Me were compared to chronological age, it was possible to make four age groups (for females and males separately), where each group showed a unique range of value for distance M-Me.

The results depict the vertical growth in the chin to be well-conserved dimension in humans in comparison to the

| Table 1: Correlation between chronological age and distance M-Me |
|---------------------------------------------------------------|
| **Gender** | **Correlation coefficient (r)** |
| Female | 0.746** |
| Male | 0.869** |

**Significant at p<0.01**

| Table 2: Distribution of values of distance M-Me in the four age groups in females |
|----------------------------------------------------------------------------------|
| **Age group (years)** | **n** | **Distance M-Me (mm)** |
| | Mean | SD | Minimum | Maximum |
| 6-7 | 5 | 12.52 | 0.8 | 12 | 14 |
| 7.5-9 | 10 | 14.55 | 0.9 | 14 | 15.5 |
| 9.5-13 | 14 | 16.11 | 0.9 | 16 | 17 |
| 13.5-21 | 5 | 18.72 | 0.7 | 18 | 19.5 |

SD=Standard deviation

| Table 3: Distribution of values of distance M-Me in the four age groups in males |
|----------------------------------------------------------------------------------|
| **Age group (years)** | **n** | **Distance M-Me (mm)** |
| | Mean | SD | Minimum | Maximum |
| 6-7 | 4 | 12.51 | 0.7 | 11.5 | 13 |
| 7.5-9.5 | 8 | 15.06 | 0.5 | 14 | 15.5 |
| 10-14 | 13 | 17.06 | 0.6 | 16 | 18 |
| 14.5-21 | 6 | 19.53 | 0.9 | 18.5 | 21 |

SD=Standard deviation
other highly variant mandibular dimensions. It sheds light on a theory that the postnatal dimensional change in the region of chin is an expression of the innate potential of the mandibular growth and is less influenced by environmental factors.

It was seen that the age range groups coincided with the prepubertal, pubertal, and postpubertal growth periods.\(^{[19]}\) Age group of 7.5–9 years in females and 7.5–9.5 years in males corresponded to prepubertal peak period with both the genders having range of 14–15.5 mm for distance M-Me. It is during this period that effective growth modification procedures can be attempted. Age group of 9.5–13 years in females and 10–14 years in males corresponded to pubertal peak period, with females having range of 16–17 mm while males having range of 16–18 mm for distance M-Me. Age group of 13.5–21 years in females and 14.5–21 years in males corresponded to postpubertal peak period, with females having range of 18–19.5 mm and males having range of 18.5–21 mm. Age group of 6–7 years in both males and females had values below 14 mm. As evident from the data, for pubertal peak and postpubertal peak age groups, males had statistically significant higher mean values of distance M-Me in comparison to females, reinforcing that although males achieve their stage of peak pubertal growth later when compared to females, they show larger amount of growth. The increase in distance M-Me even after the periods of peak pubertal growth provide further data to contribute to the view that certain amount of growth modification can also be undertaken in young adults who are outside the period of peak mandibular growth.\(^{[20]}\) It also signifies the need for a prolonged retention period as the persistent growth can bring about posttreatment relapse.

Recent concepts consider soft tissue pull as the primary mechanism for the postnatal growth of the mandible aided by some innate component. The principal sites of growth are posterior surface of the ramus and the condylar and coronoid process.\(^{[16,17]}\) Environmental factors influence growth considerably during the postnatal period at the principle sites of growth; therefore the variations in ramus height, base length, mandibular rotation, etc.\(^{[13,19]}\)

In the present study, two points on the bony chin were used — (1) Point M which was marked as the mid-point in the concavity of the mandible (which lies between the most superior point on the alveolar bone overlying the mandibular incisors [infradentale] and the most anterior point on the chin [Pog]) and (2) Menton (Me) which was identified as the lowest point on the symphyseal shadow of the mandible. Bony chin was used considering that it is not an active growth site in itself.\(^{[16,17]}\) Points M and Me were selected considering that they are easily located on lateral cephalogram and are reproducible. Since both these points lie within the mandible, mandibular rotational changes do not alter their relation to each other. The requisites of an “ideal” biologic indicator as given by Baccetti \textit{et al.}\(^{[1]}\) include that it should not require any additional X-ray exposure and should show ease in recording and consistency in the interpretation of data. The method should present with a definable stage or phase that coincides with the peak in mandibular growth in the majority of individuals and a definable stage or peak that occurs before the peak in mandibular growth in the majority of individuals. Distance M-Me fulfilled all these requisites.

The disadvantage of distance M-Me is that it is an absolute measurement, so any variation in the radiographic technique can produce variations in magnification which can alter the values. Therefore, it is required that principles of standard radiographic technique are followed as was also done in the present study.

Chronological age is often incorrectly determined in cases where the actual date of birth is not known. The authors were of the view that since distance M-Me showed age-related increase in dimension, appears to be less influenced by environmental factors, and is a mandibular parameter in itself, its values can more efficiently predict the stage of mandibular growth which is required in orthodontics and dentofacial orthopedics. It can be used as a valuable adjunct or substitute to chronological age when predicting mandibular growth.

The limitation of the present study was that it was carried out on a small sample size because of which testing of further statistical parameters was not possible.

**Conclusions**

- Distance M-Me and chronological age are highly correlated. Distance M-Me showed linear increment with age and the absolute values of distance M-Me could be classified age-wise into a unique range. It signifies a well-conserved linear dimension
- Prepubertal peak period in both males and females showed a range of 14–15.5 mm for distance M-Me. This is the ideal time for attempting growth modification procedures
- Values of distance M-Me can be directly read for predicting the stage of mandibular growth and can be used as a valuable adjunct/substitute to chronological age
- Further studies need to be undertaken on larger sample size taking facial form and facial growth pattern into consideration along with testing of further statistical parameters. Further studies also need to be undertaken in people of different racial origin, to find out whether the range of values specified are universal or they are subject to racial variation.

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Conflicts of interest
There are no conflicts of interest.

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