**REVIEW OF LITERATURE**

**Steiner CC (1953)** developed skeletal values which he believed would give maximum clinical information with the least number of measurements. The S-N plane was selected as the reference plane. The norms provided a comprehensive cephalometric database and could be used to classify and study patients with dentofacial deformities.

**Tweed CH (1954)** selected four of his treated cases with pleasing facial esthetics. He evaluated the FMIA, FMA, and IMPA angles and found it to be 65, 25 and 90 degrees respectively. He further selected 45 different samples and found that the values for FMIA, FMA and IMPA were similar to his treated sample.

**Vasanth B. Kotak (1964)** conducted a study on Gujarati girls between the ages of 14 years and 17 years using the angular and linear measurements suggested by William Downs. He concluded that the skeletal pattern show a distal positioning of the mandible. Though the dental pattern had a distinctly protruded nature yet the appearances of the cases studied were pleasing. This means that while treating this group of patients a slight protrusion of the anterior teeth will not mar their features. Also the point that lower anteriors are stable only when they are at right angle to the mandibular plane, is difficult to confirm, because mean angle observed was much higher to that advocated by other workers like Downs, Tweed, Margolis etc.

**Ravindra Nanda & Ram S. Nanda (1969)** conducted a study on dentofacial pattern of the North Indian (Lucknow) Hindus. Fifty subjects were selected for their excellent dentofacial harmony and proportions. The measurements obtained were compared with the Downs norms available on other racial groups. They concluded that skeletal norms obtained on the Lucknow Hindus were almost similar to the American White, but were retrusive when compared with the Chinese, Negro and Japanese. The dental pattern of the Lucknow sample was more protrusive than the American White; it was retrusive as compared with the Chinese and the Negro. The norms of the North Indian (Lucknow) Hindu females when compared with the norms from Gujarati females had a more protrusive dental pattern, although the skeletal patterns of the two samples were almost identical.
Sidhu S.S., Shourie K.L & Shaikh H.S. (1970) conducted a study on Maharastrian Population for the age group of 12-18 years and recorded following cephalometric values as Maharastrian norms - SNA 82.7±7.42, SNB 79.4±7.82, ANB 3.3±3.64, U1-NA 6.7±3.74, L1-NB 7.6±2.68 and FH-SN at 6.0±5.86.

Savannur A.L & Shourie K.L (1970) conducted a study on facial proportions in vertical dimension through cephalometrics for maharastra population. The age group of the study was 19-33 years, and sample size was 50 males. They recorded the following cephalometric values for the maharastrian population as nasal height at 56.02± 2.75, Sub Nasal Height as 16.92±2.84, Mandibular Height as 30.78±3.86, Dental Height as 19.78±2.21, total facial Height as 123.1±1.07 and Posterior Facial Height as 87.6±0.86.

Valiathan A (1974) carried out a cephalometric study using Downs’ analysis, on 20 adult volunteers with age range of 20-48 years having class I occlusion with acceptable aesthetics and balance. Author found that mean facial angle of Indian group was smaller; angle of convexity was greater than that of Downs’ group of North American Caucasians. Author also found that mandibular plane angle and Y axis range was much wider in the Indian group. On comparing Downs’ dental pattern, author found that Indians have more procumbent dentition with more protrusive upper and lower incisors. Study concluded saying that, while skeletal pattern of people from India had an overall similarity with the skeletal pattern of Caucasians from North America, it differed significantly in its greater convexity.

Rajendran V.C., Prasad A.R., & Venkaiah V (1975) conducted a study on cephalometric norms for mysoreans for an age group of 18-21 years with a sample size of 20. They recorded SNA 83.45±3.60, SNB 80.50±3.30, ANB 2.95±2.20, U1-NA 6.65±0.41, L1-NB 6.85±0.38, U1-LI 122.95±5.60 and GO-GN to SN as 29.01±4.30.

Valiathan A (1976) carried out a study in which Tweed’s analysis was tested on Indian adults and an attempt was made to establish cephalometric norms for Indians using the same. Study had non-orthodontically treated 20 subjects between age group of 20-48 years. Study concluded that FMA was lower for Indian group and FMIA and IMPA indicated more labially inclined lower incisors.
Kannapan JG and Balasubramaniam MR (1976)\textsuperscript{13} carried out a study on 100 individuals of both sexes, to establish cephalometric norms for individuals in the age groups of 9-20 years residing in Madras city using Steiner’s analysis. Samples were divided into 4 age groups, 9-11 years, 12-14 years, 15-17 years and 18-20 years. First and second group consisted of 30 individuals each and third and fourth group consisted of 20 individuals each. The selected samples had Angles class I molar relation with normal overjet and overbite. Study found that as the age advances, there is forward position of maxillary and mandibular basal arches in relation to cranial base as suggested by angular measurements SNA, SNB, SND and ANB. Authors also found that, as the age increases, interincisal angle and effective length of mandible increases but mandibular plane angle decreases suggestive of increase in ramus height and there is not much difference in the relationship of incisor to NA and NB plane. Values that were obtained in the study showed little variation from the Steiner’s values.

Patel H.M., & Joshi M.R. (1977)\textsuperscript{14} studied differences between the dentofacial patterns associated with Class 2 div 1 malocclusions and normal occlusions. The sample size was 30 with 15 males and 15 females of an age group of 12-16 years gujrathis. They recorded the values for males SNA 80.60±4.93, SNB 78.10±4.47, ANB 2.50±1.70, U1-NA 7.27±1.91, L1-NB 7.47±1.77, U1-L1 118.27±8.01 & GoGn-SN 29.40±5.15. For Females the values were SNA 81.93±3.85, SNB 78.40±4.16, ANB 3.53±2.71, U1-NA 5.87±1.81, L1-NB 6.80±1.97, U1-L1 123.0±7.20 & GoGn-SN 28.73±4.40.

Khatri V.T., Modi A.B., & Parikh N.H. (1978)\textsuperscript{15} did a comparison study of mandible between normal occlusion and angles class 2 div 1 malocclusion for an age group of 13-15 years. The sample size was 20 with 10 males and 10 females. They recorded the values of Co-Me at 110.75±4.37 and Co-Go as 56.65±3.37 and Go-Me as 69.10±4.13.

Samir E.Bishara (1981)\textsuperscript{16} conducted a study to explore the possibility of developing a limited number of normative longitudinal cephalometric standards for males and females between 5 years of age to adulthood. The subjects in the study included twenty males and fifteen females with clinically acceptable occlusion and no apparent facial disharmony. All subjects were Caucasians, and none had undergone orthodontic
therapy. Seventeen angular measurements and ratios of face heights derived from
linear dimensions were examined for significant changes between 5 years of age and
adulthood. Five cephalometric standards which can be used by the orthodontist for
diagnostic purposes were developed. These standards are specific for sex and
applicable within an age range. For the vast majority of cases, only one of these
standards needs to be used to evaluate the patient before, during, and after orthodontic
treatment.

**Chandranee (1981)**\(^{17}\) conducted a Roentgenographic Cephalometric study of North
Indian Children of Chandigarh population of 4-5 years. The sample size was 46 with
25 males and 21 females and values recorded for SNA 80.48±2.95, SNB 75.41±2.77,
ANB 5.07±1.59, U1-NA 0.14±1.71, L1-NB 2.80±1.31 & MP-SN 32.03±3.64. The
values recorded for 11-13 years for sample size of 46 with 22 males and 24 females
was SNA 81.68±2.37, SNB 78.57±2.81, ANB 3.12±1.81, U1-NA 4.92±2.05, L1-NB
6.00±1.66 & MP-SN 30.60±4.63.

**Joseph E.Jamison et.al (1982)**\(^{18}\) conducted a longitudinal study to examine the
changes in the maxilla and the maxillary-mandibular relationship between 8 and 17
years of age, as they relate to standing height, which is one indicator of skeletal
maturation. The subjects for this study consisted of twenty males and fifteen females
for whom cephalograms were taken annually between the ages of 8 and 17 years.
Descriptive statistics summarized the changes in standing height and the facial
parameters from 8 to 17 years of age. The findings in the present investigation
indicated that (1) the growth profile of the absolute and incremental changes in
standing height and the various facial parameters were in general significantly
different between males and females; (2) the growth profile of standing height was
significantly different from the parameters describing maxillary length and
relationship as well as maxillary-mandibular relationship; (3) the changes in maxillary
length (A- Ptm) were significantly larger in the maximum period of growth than the
other two periods of growth for both males and females; (4) the changes in maxillary
relationship were significantly different in the maximum period of growth than in the
other two periods of growth in males only; (5) the change in maxillary-mandibular
relationship was not significantly different in the three periods of growth; (6)
autocorrelation analysis revealed that the growth profile of the facial parameters could
not be predicted from the growth profile of standing height of the same individual;
that is, the growth profile of height was found to have little predictive value in determining the growth profile of any of the other parameters.

_Samir E. Bishara et.al (1984)_ studied Changes in facial dimensions and relationships between the ages of 5 and 25 years this study was done to quantify the changes in facial dimensions and relationship as well as in standing height which occur between the age of 5 years and adulthood. The total change between the ages of 5 and 25.5 years was arbitrarily divided into three periods of growth: from 5 years to 10 years of age (GP I), from 10 to 15 years of age (GP II), and from 15 to 25.5 years of age (GP III). The subjects included twenty males and fifteen females for whom complete sets of data were available for the period of this study. All subjects had clinically acceptable occlusion and had undergone no previous orthodontic treatment. The findings in this investigation indicated that (1) the timing and magnitude of change in the various facial parameters differ during the same growth period as well as between males and females; (2) in general, most of the changes in the various parameters in females occurred in GP I and GP II, whereas in males the changes were relatively distributed over the three periods of growth; (3) changes in GP III for some parameters were of clinically significant magnitude (for example, in females the ratio of anterior face heights decreased significantly in GP III whereas in males a significant increase occurred in Ar-Pog, SNB, and SNPog, while the maxillary and mandibular relationship, the ratio of anterior to posterior face heights, MP-SN angle, and the convexity of the soft-tissue profile continued to decrease significantly during GP III); (4) during GP III, with the exception of standing height and mandibular depth, there were no significant differences in the magnitude of change between 15 and 17 years of age and the change after 17 years of age.

_Valiathan A and John KK (1984)_ conducted a study to develop norms of soft tissue profile of 50 adults from Kerala. Cases were selected on the basis of class I molar relationship and Steiner’s acceptable profiles. Lateral cephalograms were taken and following analytical planes were drawn: Apollo line, Holdaway line and Burstone’s subnasal-pogonion plane. Study concluded that Apollo line cannot be used on adults from Kerala without modification. All the 3 planes showed lower lip prominence. Burstone analysis also showed mid facial prominence.
Jalili VP and Shaikh HS (1984) analyzed the vertical dimension of Maharashtrian males cephalometrically. They divided the sample into an adolescent (13-16 years) and adult group (18-25 years) with normal occlusion and pleasing profile. They observed a significant increase in the lower face height (infradentale to Gn) while the total face height did not show a significant difference when the two groups were compared.

Peter M. Sinclair & Robert M. Little (1985) conducted a study using Cephalometric head films from a sample of 65 untreated normal persons, who were evaluated to determine the nature and extent of the normal dentofacial maturation process of untreated normals. Thirty-four parameters were examined in the mixed dentition (9 to 10 years), the early permanent dentition (12 to 13 years), and early adulthood (19 to 20 years). Results showed the importance of maxillary development, particularly in the vertical plane, as it was associated with the amount and direction of sagittal mandibular growth. "Late mandibular growth" was found to be a forward (bite-closing) rotation of the mandible that occurred after the cessation of vertical maxillary growth. Condylar growth amount and direction were influential in determining the degree of sagittal mandibular change. The degree of forward (bite-closing) mandibular rotation was strongly associated with the amount of both maxillary and mandibular molar eruption. Incisor positions were found to remain relatively constant, showing compensations for the amount and direction of skeletal growth.

Samir E. Bishara & Jane R. Jakobsen (1985) studied Longitudinal changes in three normal facial types to describe and compare the dentofacial relationships of three normal facial types (long, average, and short). Comparisons of the absolute and incremental changes between 5 years and 25.5 years of age were made both longitudinally and cross-sectionally. The subjects consisted of 20 males and 15 females for whom complete sets of data were available for the period of this study. The investigation resulted in the following findings. (1) Most persons (77%) have been categorized as having the same facial type at 5 and at 25.5 years of age. There is a strong tendency to maintain the original facial type with age. (2) Comparisons of the growth curves of the different parameters--with the exception of the incremental curves for MP:SN and Pog:NB in males--consistently demonstrated parallelism of the curves, regardless of the facial type. On the other hand, comparisons of curve
magnitude indicated significant differences among the three facial types. (3) The persons within each facial type expressed a relatively large variation in the size and relationships of the various dentofacial structures. (4) Significant differences in the dentofacial parameters were present between males and females with the same facial type. The differences among facial types were not identical in males and females. (5) Longitudinal analysis of the data lends more consistent and, therefore, more meaningful results than cross-sectional comparisons when facial growth trends need to be evaluated. This is because growth changes are often subtle and of magnitudes not readily observed when the data are evaluated cross-sectionally.

P.H.Buschang P H et. al (1986)\textsuperscript{24} conducted a study on polynomial approach to craniofacial growth by description and comparison of adolescent males with normal occlusion and those with untreated Class II malocclusion. Orthogonal polynomials are used to model the craniofacial growth of adolescent boys, aged 11 through 14 years, and to evaluate variation between normal occlusion and untreated Class II malocclusion. The results show linear growth (velocity) for the maxillary measures; their angular relationships to the cranial base remain stable throughout the age range. Mandibular measures shows growth velocity and acceleration, indicating the adolescent growth spurt. For the majority (80\%) of measures, boys with normal occlusion and those with Class II malocclusion were not significantly different. Mean growth velocity of basion-nasion is significantly greater for subjects with Class II, Division 1 malocclusion. Total mandibular length and the ANB angle display significant mean size (constant) difference between boys with normal occlusion and boys with untreated Class II malocclusion. The groups are comparable in growth velocity and acceleration, indicating that the size difference are established before 11 years of age and maintained during adolescence.

Seppo Jarvinen & Dr.Odont. (1987)\textsuperscript{25} studied the factors causing differences in the relative variability of linear radiographic cephalometric measurements. Certain factors causing variation of linear radiographic cephalometric measurements were evaluated using the regression analysis. The material of the study consisted of data from three earlier investigations and included 73 measurements of four separate samples of children and young adults. Approximately 75\% of the variation of the variation coefficient (V) could be attributed to the variation in the length of the measurements (X) and thus mainly to the mathematic properties of V. Thus, differences in the
relative variation did not always indicate differences in the absolute variation (SD). Two factors were extracted that had an increasing effect upon the variability – the location of the reference points on an osseous contour and the location of the reference points (one of both) in the mandible. The great variability of the reference points located on osseous contours was probably caused by local changes in bone configurations, and the great variability of the measurements involving the mandible probably indicated some specific growth changes in the size, form, and rotation movements of this bone. In clinical use such reference points that include relevant information only and that could be fixed by consistent features of the local morphology should be preferred.

Kaarina Haavikko and Auli Rahkamo (1989) studied Age and skeletal type-related changes of some cephalometric parameters in Finnish girls. The aim of the present study was to define some cephalometric standards in a group of 217 Finnish girls from 7.0 to 18.0 years of age and furthermore to estimate the influence of the skeletal classes on these standards. Age-related changes were seen between the standards of the youngest (7.0-9.5 years) and the oldest (14.5-18.0 years) group where 9 out of 15 of the inspected angles increased with age, three of them ANPr***, SNPg** and SNB* significantly, and 6 decreased, four of them significantly: ANPg**, ANB**, NL/ML* and RL/ML*. The cranial base angles did not show any significant age-related or skeletal type-related variations. Between the skeletal groups I and II significant differences were seen in 11 variables. Between skeletal I and III groups, 7 angles were significantly different. The results demonstrate that when cephalometric standards are used, they should be derived from that population, they should be age related, and the skeletal pattern should be taken into account.

Kharbanda OP, Sindhu SS and Sundram KR (1989) carried out a study on 48 Aryo Dravidians. It included 25 males and 23 females having excellent occlusion with no crowding and rotations. Study found that Aryo-Dravidians, Maharashtrians and Tamilians had close values for SNA, SNB and ANB as compared to Steiner’s norms. Study also compared their data to Chinese and Iranian population and found that Chinese had slightly protrusive upper and lower denture bases related to nasion causing high mean values of SNA, SNB and less mean value of ANB, while Iranians had a more straight profile as compared to Aryo-Dravidians. Downs analysis suggested Parsees had highest mean facial angle among Indians while Aryo Dravidian
group had small Facial angle as compared to Chinese, Caucasians and Negros. Indians possess low FMA when compared to Negros and Chinese. Parsees had highest Y-axis angle thereby causing a more retrusive and vertical lower face compared to North Indians and Maharashtrians. Indian group exhibited more protrusive face compared to Caucasians but less than the Chinese and Negros, while among Indians, Maharashtrians had the most protrusive face. IMPA was observed to be higher among Indians than Chinese and even Negros. Interincisal angle was lowest among Maharashtrians and highest among North Indians. Study concluded saying that Aryo-Dravidians have more protrusive skeletal and dental pattern as compared to Caucasians but near to Chinese and less than Negros, but when compared to Gujaratis and Maharashtrians, Aryo Dravidians have retrognathic facial skeletal and denture pattern. These norms presented for Aryo-Dravidians can be used to study skeletal deviations of malocclusion amongst Indians.

Samir E.Bishara et. al(1990)²⁸ conducted Cephalometric comparisons of dentofacial parameters between Egyptian and North American adolescents. The purpose of this study was to develop cephalometric standards for the Egyptian adolescent boys and girls and to compare them to a matched lOWA adolescent sample. The Egyptian sample consisted of 39 boys and 51 girls with a mean age of 12.5 years. The Iowa sample consisted of 33 boys and 22 girls with a mean age of 13.0 years. Basic descriptive statistics were calculated for the overall group comparisons, and the statistical significance was predetermined at the 0.05 level of confidence. Comparisons between the boys and girls in both populations indicated that the boys were larger in the linear dimensions of the cranial base and face heights than the girls. Comparisons between the Egyptians and the lawans indicated that Egyptian boys have a tendency toward bimaxillary dentalprotrusion and a decreased overbite as compared with Iowa boys. Egyptian girls have a relatively more convex profile and a tendency toward mandibular dental protrusion. When the overall findings are evaluated, it could be concluded that, in general, there is a great similarity in the overall facial morphology between the Egyptian and Iowa populations.

Akira Suzuki, & Yasuhide Takahama (1991)²⁹ studied on using Parental data to predict growth of craniofacial form. The sample for this study consisted of 250 families. From 850 lateral and posteroanterior cephalograms, 81 variables from the X, Y co-ordinates of 67 landmarks were calculated and matched with the normal
distribution. Principal component analysis was used to summarize these 81 variables in proper factor scores. The craniofacial patterns of 500 adults were classified by cluster analysis on the bases of those factor scores. This study introduced the concept of “similar parent” and “dissimilar parent” instead of the father and mother equally. Finally, the following model for predicting the individual growth of craniofacial characters was obtained. The predicted value $Y(t)$ is here

$$Y(t) + C_1 X(s) + C_2 X(d) + \frac{C_3}{1 + \exp (C_4(t - C_5)[t - C_5])} + C_6$$

Here

$$\frac{C_3}{1 + \exp (C_4[t - C_5])}$$

Is the logistic curve used in growth studies, $C_1 X(s)$ is for the similar parent of a child, and $C_2 X(d)$ is for the dissimilar parent. Multiple regression functions were calculated for both sexes in each of four craniofacial patterns. The errors of prediction at the average age of 18 years from the data at the average age of 11.6 were 1.12, 2.88, 2.87, 3.14 and 1.93 mm for the respective distances S-N, N-Me, S-Me, Gn-Cd, and G-G. These errors in our growth prediction are much smaller than in ordinary normal facial diagrams and may be considered negligible for orthodontic clinical application.

**John KK and Valiathan A (1991)**[^30] cephalometrically evaluated the dentoskeletal-facial characteristics of adults from Kerala, according to Steiner’s and Holdaway’s method. They found the normal occlusion group in the present study had protrusive dental base as compared to the Caucasians. Both maxillary and mandibular anterior teeth were more proclined in the normal group. In comparison to values of class II and class III groups with normals, it was found that there was no significant difference in the maxillary protrusion. The main difference was found to be in mandible, which was retruded in class II and protruded for class III groups.

**Stephen F Snodell et al (1993)**[^31] conducted a study on longitudinal cephalometric study of transverse and vertical craniofacial growth. Longitudinal growth changes were studied from postero-anterior cephalometric radiographs of 25 male subjects from 4 to 25 years of age and 25 years of age and 25 female subjects from 4 to 20

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years of age who had Class I skeletal and dental patterns. Growth for males continued past age 18 years for all skeletal measurements, except for maxillary width. Growth for females was completed by 17 years for all skeletal measurements. At 6 years of age the transverse measurements had a greater percentage of the adult size completed than vertical measurements for both males and females. Gender differences at age 6 years were in the mean widths for the cranium, face, and maxilla. At age 12 years the differences were in cranial width, maxillary width, and maxillary and mandibular intermolar width (6-6). There were gender differences at age 18 years for all the variables, except for nasal width and mandibular intermolar width (6-6). Regression lines provided strong-to-moderate predictive equations to determine the size of most of the measurements at age 18 years, if the value at age 6 years is known.

Amal El-Batouti, Bjorn Ogaard & Samir E. Bishara (1994) conducted a study to develop a normatic cephalometric standards for Norwegians form 6 and 18 years of age, Caucasian 39 females and 35 males of Nittedal growth material were selected. Significant differences between females and males were present particularly at ages 12 and 15 years of age. There was a significant mean increase in NL/NSL in both sexes from 6 to 15 years of age, but more in females. There was a significant mean decrease in ML/NSL from 6-18 years of age, and the angle was significantly smaller in males than females. The anterior and posterior facial height increased in both sexes from 6 to 18 years of age. The largest increase was in males. Males showed slightly more proclined upper incisors at age 9, 12, and 15 years than females. S-N-A increased more in males than females with the largest increase between 9 and 15 years of age. S-N-B increased in both sexes from 6 to 18 years of age with the largest increase in males. In conclusion, there were significant differences in a number of craniofacial parameters between males and females, especially at age 12 and 15 years.

Alf Tor Karisen (1994) studied Craniofacial growth differences between low and high MP-SN angle males, through a longitudinal study. Craniofacial growth was followed longitudinally in two groups of boys with low and high MP-SN angles. The purpose was, first, to reveal group differences in dimensional change, and second, to find whether such differences were associated with a group difference in mandibular growth rotation. Group differences in dimensional change were explained by a difference in matrix rotation of the mandibular corpus, especially in the 6 to 12-year period. In the 12- 15 year period, matrix rotation was similar in the two groups and so
were dimensional changes. Morphologically, dimensional group differences in the 6-to 12-year period were theoretically compatible with the fact that mandibular rotation was clearly more forward in the low angle than in the high angle group. Statistically, dimensional variables with significant group difference were correlated strongly with matrix rotation and, in most cases, non-significantly with intramatrix rotation.

**Ram S. Nanda & Joydeep Ghosh (1995)** conducted a longitudinal study to access growth pattern in sagittal linear measurement at Points A, B, and porion relative to the pterygoid vertical plane in a class 1 sample was done to access the sagittal relationship of Maxilla and Mandible. Serial cephalometric radiographs were traced and digitized at ages 6, 12, 18, and 24 years. The results indicated that between the ages of 6 and 24 years there was a total growth increment of 6.07, 7.53, and 11.17mm at points A, B, and pogonion respectively, in the female Class 1 sample and 9.49, 11.65 and 16.21mm at points A, B, and pogonion, respectively, in the male sample. Although the actual change in length of these measurements was larger in the male subjects than in the female subjects in terms of percentage of growth increment in each of these three measurements from age 6 to 24 years, the anterior movement at point B relative to point A, and at pogonion relative to points B and A was approximately the same for both male and female subjects. When each of the subjects in both male and female samples was rank-ordered according to the size at age 6 years, considerable individual variation was noticeable for most persons within the group. The individual variation in growth pattern in each of the different measurements continues to raise questions about growth prediction and its application in visual treatment objectives.

**Amal El-Batouti et al., (1995)** studied Dentofacial changes in Norwegian and lowan populations between 6 and 18 years of age. The purpose of this study was to compare the dentofacial changes in Norwegian and lowan populations between 6 and 18 years of age. Comparisons of the absolute and incremental changes were made both longitudinally and cross-sectionally. The Norwegian sample consisted of 39 females and 35 males, the lowa sample consisted of 15 females and 20 males, for whom complete sets of data were available for the period of the study. All subjects had a clinically acceptable occlusion and had not undergone previous orthodontic treatment. Descriptive statistics summarized the changes in 29 parameters. Longitudinal comparison of the growth curves evaluated the curve profiles and curve
magnitudes for the two populations for both males and females. The analysis of variance was also used to compare the absolute and incremental changes at ages 6, 9, 12, 15, and 18 years. The study resulted in the following findings: 1) The longitudinal growth profile comparisons of the various dentofacial parameters indicated that the growth trends of the Norwegian and Iowa groups were essentially similar. 2) The comparisons of the growth profiles of the males and females from the two populations also indicated that there were no significant differences between the shape of their growth curves. 3) The comparisons of the curve magnitude, as well as the results of the cross-sectional comparisons, indicated that Norwegians had significantly greater maxillary and mandibular protrusion, and larger proclination of the upper and lower incisors than the Iowans.

Kuniaki Miyajima et. al (1996)\(^3\) studied Craniofacial structure of Japanese and European-American adults with normal occlusions and well-balanced faces. The purpose of this study is to compare two groups of adults from different races who were selected on the basis of having normal (“ideal”) occlusions and well-balanced faces. The lateral cephalometric radiographs of 54 Japanese adults (26 men and 28 women) were compared with a sample of 125 adults (44 men and 81 women) of European-American ancestry. The samples were chosen by orthodontists of the same racial background as the sample selected. Each lateral cephalogram was traced and digitized, and differences between cephalometric measurements between groups were analyzed with completely randomized t tests. In comparison to the European-American sample, the Japanese sample, in general, was smaller in anteroposterior facial dimensions and proportionately larger in vertical facial dimensions. The facial axis angle was more vertical in Japanese subjects, indicating a more downward direction of facial development. On average, the subjects in the Japanese sample were more protrusive dentally, with a more acute nasolabial angle and a greater tendency toward bilabial protrusion. These differences, evident even in groups with so-called “well-balanced faces”, indicate that fundamental variation exists in the craniofacial structure of Japanese and European-Americans. The results of this study support the premise that a single standard of facial esthetics is not appropriate for application to diverse racial and ethnic groups.

Kudchadkar A (1997)\(^3\) did a study to evaluate craniofacial morphology of an ethnic Tibetan population using Downs’, Steiner’s and Tweed’s analysis, and their
characteristics were compared to other Mongoloid groups on whom studies were already done. Study consisted of 30 male Tibetan subjects in age group 18-25 yrs drawn from Tibetan colony Mundgod, Karnataka. Lateral cephalograms, extra oral photograph and study model casts were recorded. Films were taken in centric occlusion and the soft tissue was made visible by barium paint. Study concluded that: 1. Tibetans have more prominent chin, skeletal convexity is milder, AB plane angle is less, mandibular plane angle is much flatter, Y axis more horizontal, and the upper and lower incisors are less proclined, suggesting larger interincisal angle as compared to other mongoloid groups. 2. They also concluded that Tibetans have more prominent chin and upper- lower incisors more forwardly placed and proclined as compared to Caucasians.

**Leonard S Fishman (1997)** Studied Individualized evaluation of facial form. The purpose of this study was to establish a nonnumeric graphic approach to the evaluation of facial form. By using a centroid-based pattern of orientation, skeletal, dental, and soft-tissue morphologic characteristics can be identified that more reliably represent the uniqueness of the person and are not dependent on non-representative group-based numerical standards. The Centro Graphic Analysis (CGA) cephalomorphically demonstrates vertical and horizontal balance or disharmony in skeletal, dental, and soft-tissue form and position. The Facial Centroid Axis (FCA) provides a relatively stable reference plane that can be used for longitudinal cephalomorphic superimposition.

**Jyothindra Kumar(1999)** did a compilation of Publised Cephalometric Studies with the titled A Hand Book of Cephalometric norms for Indian Ethnic Groups which was printed and published by Dr.T. Samraj Hon. Secretary for and on behalf of the Indian Orhtodontic Society. lot of studies were grouped under grouped under the following analysis – Steiners analysis, Downs analysis, Tweeds analysis, Combined steiner & downs, Vertical analysis, Quadrilateral analysis , Palatal Angle, Vertical Proportions, Mandibular Size and Soft tissue analysis.

**Kristine S.West & James A.McNamara (1999)** studied the Changes in craniofacial complex from adolescence to midadulthood to evaluate cephalometrically the craniofacial growth changes and adjustments that occur from late adolescence to mid adulthood in persons who had no previous history of orthodontic treatment. Serial
lateral cephalograms from 58 subjects from the University of Michigan Elementary and Secondary Growth Study recalled on average in their late 40s were examined. Fifteen of the patients also had cephalograms taken in early adulthood (early 30s). Statistically significant growth changes occurred; mandibular and midfacial lengths as well as posterior and lower anterior facial heights had increased significantly for males and females over both time intervals. The pattern of expression of these changes was different in the two genders: males showed an anterior rotation of the mandible, whereas females demonstrated a posterior rotation of the mandible. Soft tissue changes also were somewhat different between genders. In males, the nose and chin grew downward and forward, with the lips generally moving straight downward. In contrast, females had nasal growth that progressed downward and forward, and there was a slight retrusion of the lips over time. Continued tooth eruption was noted in both genders as well.

Abraharm KK, Tandon S, & Paul U(2000)\textsuperscript{41} conducted a study on selected cephalometric norms in South Kanara Children. Cephalometric Norms from forty south kanara children were selected and it was found that these children have a tendency towards class II skeletal relation. Females showed a Protrusive Maxillary and Mandibular base. Certain new landmarks were also introduced, the value of which gives the molar relationship. Length of Maxillary and Mandibular bases were also standardized for class I cases.

Manish Valithan, Ashima Valithan & V Ravinder (2001)\textsuperscript{42} conducted a study on Jarabak Cephalometric Analysis Rebron. A Cephalometric comparison of the south Indians and north Indians was undertaken using Jarabak analysis. Sixty adult subjects were chosen of which fifteen were South Indian Males, Fifteen South Indian Females, fifteen North Indian males and fifteen North Indian Females. All Subjects exhibited a pleasing profile with class I Molar occlusion. Lateral cephalograms were taken, tracings drawn and analysed. A statistical comparison was made and the overall mean values obtained demonstrated that – South Indians exhibited a more Prognathic maxilla while the mandible was also found to be slightly more Prognathic than the North Indian sample. All four groups showed a similar pattern of growth. Males showed a greater amount of growth. The denture showed a procumbency in the south Indians. The skeletal and dental pattern resulted in a more convex profile among the South Indians.
Mirzen Arat et al. (2001) conducted a longitudinal study on craniofacial growth and skeletal maturation. The material consisted of the cephalometric and hand-wrist film pairs of 35 males and 43 females (78 subjects) whose development was followed for a period of 4 to 7 years. The subjects were grouped according to their skeletal maturation. Their mean ages were: Group I 10.27, Group II 11.55, and Group III 14.79 years, respectively, at the beginning of the observation period. The results show that the middle cranial base (T-W) maintained its stability in all pubertal growth periods. However, posterior cranial base length (T-Ba) increases significantly (P < 0.001) throughout the same period. There were similar increases in the vertical dimensions of the face and alveolar height throughout pubertal growth. Despite the intensified increases in both the sagittal and vertical directions, facial characteristics were constant in the sagittal direction. The skeletal development (percentage growth potential) has clearly been effective in the vertical facial development commencing in Group I and reaching its maximum level in Group II.

Chun-His Chung & Vincent D. Mongiovi (2003) conducted a longitudinal growth study to evaluate craniofacial growth in untreated skeletal Class 1 subjects with low, average, and high MP-SN angles. Sixty-eight (36 male and 32 female) untreated skeletal Class I subjects with low (<27°), average (>27°-<37°), and high (>37°) mandibular plane (MP-SN) angles from the Bolton-Brush and Burlington Growth Studies were used. Cephalograms of each subject at ages 9 and 18 were traced, and 28 parameters were measured. The difference in each parameter from ages 9 to 18 was calculated, and comparisons were made between the groups with low, average, and high angles. Results showed that, for boys and girls at age 9, the low-angle groups exhibited significantly larger SNA angle, SNB angle, facial taper, PFH, PFH:AFH, and ramus height, and the high-angle groups showed significantly larger ANS-Me and gonial angle. From ages 9 to 18, all the male and female low-, average-, and high-angle groups showed an increase in SNA and SNB angles, and PFH : AFH, and a decrease in ANB angle, convexity (more flattened face), MP-SN angle, and gonial angle (mandibular forward rotation). The dental measurements showed few changes with growth in all groups. In terms of skeletal measurements from ages 9 to 18, similar growth changes were found between the sexes in most angular measurements, but males had larger values in linear measurements than females.
Banafsheh K. Ochoa & Ram S Nanda (2004) conducted a study on Comparison of Maxillary and Mandibular growth. In this longitudinal study, serial lateral cephalometric radiographs were used to compare growth patterns of the maxilla and mandible, with hand-wrist radiographs used to assess skeletal maturity. The sample comprised 28 untreated subjects (15 female, 13 male) who were followed from ages 6 to 20 years. All subjects had Class I malocclusions without anterior crossbites. Absolute values and incremental changes for linear and angular cephalometric measurements were recorded and analyzed, and the relative growth-rate formula was used to provide an accurate index of acceleration and deceleration of growth. The SNA angle did not change significantly with age, but the SNB angle increased significantly in the male subjects. The ANB angle decreased continuously until age 14. The palatal plane descended significantly from the horizontal plane. The anterior and posterior nasal spines moved at about the same rate. The mandible grew in length twice as such as the maxilla from ages 6 to 20. With growth, the facial profiles of the male subjects became straighter as the chin became more prominent. The female subjects had less incremental growth and duration of growth of the mandible, so that the profiles remained more convex. Overall, skeletal and chronologic ages did not differ significantly, except at ages 10 and 16 in the female subjects. Individual variability pointed to the need for assessing each patient’s pattern in the general guidelines of the group pattern.

Arnold M. Riesmeijer et al. (2004) did a comparative study of craniofacial Class I and Class II growth patterns. Longitudinal craniofacial databases, including the Fels Longitudinal Study, the Michigan Growth Study, and the Nijmegen (The Netherlands) Growth Study, were compared for a set of 12 craniofacial measurements on lateral skull cephalograms. The age ranges of the subjects were 7-14 years for females and 9-14 years for males. When we compared the normally distributed databases using multiple comparisons, a small sample test statistic t for differences between means of the databases showed few statistical differences. The databases were therefore pooled, and sex-specific Class I (ANB < 4°), and Class II (ANB ≥ 4°) subsamples were analyzed with the same t test. The sizes of these subsamples ranged from 39 to 122 at the different ages. The findings showed that the Class II samples had greater SNA and SN-GoMe angles. Compared with the Class I group, shorter mandibles were found in the younger age groups of the Class II samples. No
differences were found in mandibular length (Ar-Gn) and mandibular body length (Go-Gn) in the older Class II groups compared with the Class I groups. These findings indicate that the greater mandibular lengthening in the Class II groups might have contributed to successful Class II treatment in studies in which a Class I group was the control. Because of individual biological variability, the average Class I or Class II growth pattern might not be a realistic assumption or have clinical relevance for individual patients.

**Arni Thordarson et al (2005)** studied Craniofacial changes between 6 and 16 years of age in a sample of Icelandic children was studied using Lateral cephalometric radiographs of 95 males and 87 females. Cephalograms were digitized and processed by standard methods, using the Dentofacial Planner computer software program. Angular and linear variables were calculated, including: basal sagittal and vertical measurements, facial ratio, and dental, cranial base and mandibular measurements. For the angular measurements, gender differences were not statistically different for any of the measurements, in either age group, except for the variable s-na, which was larger in the 16-yearold boys (P < 0.001). Linear variables were consistently larger in the boys compared with the girls at both age levels. During the observation period mandibular prognathism increased but the basal sagittal jaw relationship, the jaw angle, the mandibular plane angle and cranial base flexure (n-s-ba) decreased in both genders (P < 0.001). Maxillary prognathism increased only in the boys from 6 to 16 years. Inclination of the lower incisors and all the cranial base dimensions increased in both genders during the observation period. When the Icelandic sample was compared with a similar Norwegian sample, small differences could be noted in the maxillary prognathism, mandibular plane angle and in the inclination of the maxilla. Larger differences were identified in the inclination of the lower incisors.

**Dawn M. Wagner & Chun-His Chung (2005)** studied Transverse growth of the maxilla and mandible in untreated girls with low, average, and high MP-SN angles: A longitudinal study. The purpose of this study was to investigate maxillary and mandibular transverse growth in untreated female subjects with low, average, and high mandibular plane angles longitudinally from ages 6 to 18. Eighty-one untreated white girls with low (≤ 27°, n = 16), average (> 27° to < 37°, n = 41), and high (≥ 37°, n = 24) mandibular plane angles at age 6 were selected from the Bolton-Brush and Burlington Growth Studies. For each subject, longitudinal postero-anterior
cephalograms at different ages (from ages 6 to 18) were traced, and the widths of maxilla and mandible were measured. All the measurements were converted by using a magnification factor of 8.5% (the subject-to-film distance was set at 13 cm). Results at age 6, the high-angle group had narrower maxillary and mandibular widths than the low-angle group, and this trend continued until age 18. From ages 6 to 14, maxillary width showed a steady and similar rate of increase for all 3 groups (0.90-0.95mm per year), yet a plateau was reached at age 14 for all groups. Mandibular width increased at a steady rate (about 1.6mm/year) for all 3 groups until age 14, and a plateau was reached for the high-angle group. For the low- and average-angle groups, mandibular growth continued from ages 14 to 18 but at a slower rate (0.85mm and 0.39mm per year, respectively). They concluded that Vertical facial patterns (with low or high mandibular plane angles) might play a strong role in the transverse growth of the maxilla and the mandible.

Cory B.Edwards et.al (2007) conducted a longitudinal study on facial skeletal growth completion in 3 dimensions was done using Twenty - four subjects (11 male, 13 female) and concluded a distinct separation, who had annual lateral and posteroanterior cephalograms up to and including age 17 or 18 and again at age 25 or older were identified from the Iowa Facial Growth Study. Transverse, anteroposterior, and vertical facial dimensions were measured longitudinally into adulthood by using key skeletal landmarks. The results suggested for both sexes, an overlap exists at any age in the amount of growth completed for the various measurements in the transverse, anteroposterior, and vertical dimensions. Although some transverse measures (cranial width and interjugal width) attain adult size before any anteroposterior or vertical ones, there is evidence of continued growth for other transverse parameters (interzygomatic width and intergonial width). A similar overlap is seen in the anteroposterior and vertical dimensions. Hence they concluded a distinct separation, by time and dimension, is not seen in the amount of facial growth completed during development. Instead, a dramatic spread and an overlap of growth curves are observed throughout the developing years.

Nikole G. Pecora, Tiziano Baccetti & James A. McNamara Jr (2008) studied the aging craniofacial complex: A longitudinal cephalometric study from late adolescence to late adulthood. The purpose of this investigation was to evaluate craniofacial growth changes from late adolescence through late adulthood in participants from the
University of Michigan Elementary and Secondary School Growth Study. Methods: This was a recall study with 39 subjects (19 male, 20 females). Their lateral cephalograms taken during late adolescence (T1; mean age, about 17 years), midadulthood (T2; mean age, about 47 years), and late adulthood (T3; mean age, about 57 years) were evaluated. To test for significant differences between times, sexes, and the sex and time interaction, repeated measures analysis of variance was used. For the comparisons of time (T1 vs T2, T2 vs T3), the nominal α level was set at 0.01. Skeletal changes were significant only from late adolescence to midadulthood; soft-tissue changes were significant from late adolescence to midadulthood, and mid- to late adulthood. Changes in skeletal tissues consisted of increases in sella-nasion length, midfacial length, and lower anterior facial height. Sex the men, on the other hand, had more forward rotation of the mandible and increased chin prominence. Mandibular growth was greater in the men. Changes in the soft tissues were the most remarkable and included significant thinning and elongation of the upper lip. Significant changes in the nose took place, including drooping of the nasal tip and columella, the latter leading to more acute nasolabial angles. Conclusions: Our findings in this longitudinal study provide insights on several significant changes in the aging craniofacial complex.

ArunKumar K V, Viveka Vardhan Reddy & David P.Tauro (2010) conducted a study to establish Cephalometric norms for the South Indian (Karnataka) Population based on Burstone’s analysis. The sample comprised of lateral cephalograms taken in natural heas position of 100 participants. The cephalograms were traced, analysed and interpted using the landmarks and values given by burstone’s analysis. Statistically significant skeletal differences were found between men and women of the south Indian origin in comparision to Caucasian origin. Men had decreased facial divergence, anterior maxillary dental height and Proclined upper incisors. Women had marginally increased cranial base, increased midfacial height and Proclined upper incisors.

Abilash O Yadav et al (2011) studied the normal dentofacial pattern of adult population belonging to Central India using cephalometric radiographs of 76 central Indian adults (38 males and 38 Females) with class I occlusion and acceptable facial profile using Legan and Burstone comprehensive cephalometric analysis. Their mean values were compared with those of Caucasian adults. The study revealed that central
India males demonstrated greater anterior cranial base length and greater inclination of upper and lower incisors. Females demonstrated greater posterior cranial base length, increased upper anterior and posterior facial height and increased maxillary length. Ramal length was increased and chin depth was reduced in both the sexes.

Sharma JN (2011)\textsuperscript{53} carried out a study to establish the Steiner’s cephalometric norms for a Nepalese population and compare the gender and interracial variations in dento-skeletal and soft tissue structures, and also to test the null hypothesis that there are no racial differences in cephalometric measurements between Nepalese, Caucasians and other populations. One hundred and twenty lateral cephalograms of Nepalese subjects aged 16-21 years with class I normal occlusion and balanced facial esthetics were selected. Steiner’s ideal values were compared with Indo-Aryan Nepalese means and Japanese means with Mongoloid Nepalese means and Mongoloids with Aryans. It was found that differences in the cephalometric values exist between the two ethnic groups in Nepal, as well as between our Nepalese sample and published Caucasians and Japanese norms.

Farishta S et al (2011)\textsuperscript{54} carried out a cephalometric study on 80 Chattisgarh adults in the age group of 18-25 years having acceptable profile and occlusion. Their aim was to establish skeletal and dental parameters in these individuals and compare them between male and female subjects of Chattisgarh and also with the Caucasians and other groups by means of Steiner’s analysis. This study found that Chattisgarh samples had more protrusive profile both skeletally and dentally as compared to the Caucasian population and had more horizontal growth pattern. Chattisgarh female group had more prognathic maxilla and chin than the male group. Study concluded saying that certain fundamental variation exists in the craniofacial structures of the Chattisgarh population when compared with Steiner’s norms.

Rajeev Gulati & Shikha Jain (2011)\textsuperscript{55} conducted a study to develop Cephalometric norms for orthognathic surgery for North India (Eastern Uttar Pradesh). The study sample consisted of 50 males and 50 females. All reference points, landmarks, and measurements were made according to cephalometrics for orthognathic surgery (COGS) system. They concluded that male subjects indicated greater prominence of chin relative to the face, decreased posterior divergence, infroeruption of upper and lower molar as well as lower incisors, decreased total effective length of
the maxilla, tendency towards class III occlusion, and procumbent incisors. Female subjects, however, indicated increased anterior cranial base length, greater prominence of chin relative to the face, Prognathic maxilla and mandible, increased middle third facial height, infraerupted lower incisors, increased mandibular body length, and procumbent lower incisors.

Tiziano Baccetti, Lorenzo Franchi & James A McNamara Jr (2011)\textsuperscript{56} studied Longitudinal growth changes in subjects with deepbite. This study was a cephalometric evaluation of the growth changes in untreated subjects with deepbite at 4 time points during their developmental ages (from the early mixed dentition to the permanent dentition, and from the prepubertal phase to young adulthood). Methods: A sample of 29 subjects with deep bite (overbite >4.5mm) was followed longitudinally from about 9 through about 18 years of age. Dentofacial changes at 4 times, defined by the cervical vertebral maturation method, were analyzed on lateral cephalograms. Non-parametric statistical analysis was used for comparisons. Results: Overbite improved on average by 1.3mm between the first and last measurements; it worsened significantly during the prepubertal period, but it improved in 83% of the subjects and self-corrected in 62% of the subjects. Improvements in overbite were related to the initial amount of maxillary incisor proclination. The significant improvement in overbite during the adolescent growth spurt depended on the amount of vertical growth of the mandibular ramus and the eruption of the mandibular molars. They concluded Subjects with deepbite showed worsened occlusal conditions during the prepubertal and mixed dentition phases, but had significant improvements thereafter. Improvements in overbite cannot be predicted on the basis of skeletal vertical relationships. These results provide useful indications for appropriate orthodontic treatment timing for an increased overbite.

Eric Vela et al., (2011)\textsuperscript{57} studied differences in craniofacial and dental characteristics of adolescent Mexican Americans and European Americans. The purpose of this study was to compare the soft-tissue profiles matched Class I adolescent European Americans and Mexican Americans. The secondary aim was to explain profile differences based on group differences in soft-tissue thickness, skeletal morphology, dental position, and tooth size. The study pertained to 207 untreated Class I adolescents, including 93 Mexican Americans and 114 European Americans. Lateral cephalometric and model analyses were performed to quantify morphologic
differences. Two-way analyses of variance were used to evaluate ethnicity, sex, and their interaction. Results: Mexican Americans had significantly (P<0.05) greater lip protrusion and facial convexity than did European Americans. Mexican Americans had smaller craniofacial dimensions and larger teeth, resulting in maxillary and mandibular dentoalveolar protrusion. Mexican Americans also had thicker soft tissues and greater maxillary skeletal prognathism than European Americans. The combination of thicker soft tissues, maxillary skeletal prognathism, and dentoalveolar protrusion explained the protrusive lips of Mexican Americans. The greater facial convexity of Mexican Americans was due primarily to maxillary prognathism and mandibular hyperdivergence. Sex differences pertained primarily to size; the linear dimensions of the boys were consistently and significantly larger than those of the girls. They concluded European American normative data and treatment objectives do not apply to Mexican Americans. Knowledge of the soft-tissue, skeletal morphology, and dental position differences should be applied when planning treatment for Mexican American patients.

Satinder Pal Singh et al. (2013) conducted a study to establish cephalometric hard tissue norms for orthognathic surgery for north Indian subjects. A total of 100 young adults which consisted of 46 males and 54 females with the age range of 14-24 years with balanced facial profile and minimum arch length discrepancies were chosen for the study. Lateral cephalograms with teeth in occlusion were recorded and analyzed manually to establish the norm. The mean values of various cephalometric hard tissue variables for north Indian males and females were compared with those of Caucasians. All the cephalometric parameters for orthognathic surgery except mandibular length and lower incisor inclination were compared among North Indian males and females. The mandibular length was significantly more among North Indian males than females and the inclination of lower incisors was significantly more among North Indian females than males. However many of the cephalometric parameters for orthognathic surgery were significantly differently among north Indian and Caucasian males and females.

Jay Sinojiya et al. (2014) conducted a study to establish Soft Tissue Cephalometric Norms for skeletal and dental relationships amongst the Mahabubnagar adult population. Sixty subjects – 30 males and 30 females subjects from different parts of mahabubnagar in the age group of 18-25 years were selected at random for the study.
and lateral cephalograms were taken. Overall 46 measurements including 40 linear, 6 angular parameters were used. The values obtained from the study showed significant difference in most of the parameters from that of Arnett et al., norms and between males and females within Mahabubnagar population.

**Tripti Tikku et al.,(2014)** conducted a study to establish cephalometric norms for orthognathic surgery in North Indian population using Nemoceph software. 100 orthodontically untreated subjects having pleasing profile and normal occlusion in the age range of 18-25yrs were selected. 16 linear and 6 angular hard tissue parameters of COGS analysis were analyzed using nemoceph software for the males and females separately. They concluded that north Indian males and females had smaller anterior cranial base length with Prognathic maxilla and mandible, protrusive chin with poor chin form, decreased facial height, decreased posterior maxillary height with anticlockwise rotation of mandible, increased anterior and posterior maxillary dental heights, decreased ramal and corpus length, clockwise rotation of occlusal plane, presence of sagittal discrepancy between maxillary and mandibular denture bases in comparison to Caucasian males and females respectively. North Indian females had more proclination of mandibular incisors than Caucasian females. Sexual dimorphism was also evident in the present study with males exhibiting significantly larger cranial base length, greater middle third facial height and posterior maxillary height, counterclockwise rotation of mandibular plane, greater anterior and posterior mandibular dental heights and longer ramal and corpus length in comparison to females.