Introduction:

Cephalograms have become an indispensable part of orthodontics, ever since its introduction in 1931. Conventionally, lateral cephalograms are used in orthodontics for monitoring growth, diagnosis, treatment planning, assessment of treatment progress, and evaluation of final outcome. This extensive use of cephalometric radiography in orthodontics has led to a continued quest for precise identification of anatomic landmarks. But as lateral cephalograms are 2D projections of 3D structures, identification of these landmarks in conventional cephalograms are subjected to error. With the advent of cone-beam computed tomography (CBCT), this problem is largely solved. Synthesized cephalometric images produced from CBCT scan can be used for the identification of common cephalometric landmarks which are more accurately defined using CBCT. However, a large field-of-view scan is required for obtaining a synthesized cephalometric image which is not indicated for routine orthodontic practice as[1,2] as it exposes the patient to more radiation and is not in accordance to ALARA Principle.[3] Due to higher radiation dose, CBCT should not be applied on a regular basis as a standard imaging procedure replacing lateral cephalograms and/or panoramic radiography.[4] Thus, lateral cephalograms are still the radiograph of choice for routine orthodontic cases and for assessment of growth and treatment changes.

Materials and Methods:

Lateral cephalograms of seventy patients were selected on the basis of ability to locate point A with considerable degree of accuracy. The sample was divided into two groups: Group I consisted of 35 participants with retroclined upper incisors and Group II, 35 participants with proclined upper incisors. Three alternative methods for point A estimation were evaluated for reliability in vertical and horizontal planes.

Results:

In both the groups, mean differences between SNA-SNA2 and NA-NA2 was found to be least and correlation coefficient was found to be highest for SNA-SNA2 and NA-NA2.

Conclusion:

Point A2 is the most reliable alternative to point A in both the groups and in situations where anterior contour of the maxilla is obscured, point A1 can be used as a reliable alternative to point A.

Keywords:

Lateral cephalogram, Point A, Point A alternatives, reliability, subspinale
For successful cephalometric evaluation, exact and consistent identification of anatomic landmark is a must. Various techniques have been used to improve the physical image quality of lateral cephalograms for correct identification of landmarks such as the rare earth phosphors in intensifying screens, attenuation of the radiation beam, or even the use of a second beam. But despite improved techniques, occasionally certain landmarks are still difficult to locate because of conflicting anatomic details or conceptual judgment. One such landmark is point A or subspinale. Subspinale is defined as the deepest midline point on premaxilla between anterior nasal spine (ANS) and prosthion.\[^3\]

Cases where identification of point A is difficult, like due to the variations in the structure of the skeleton, soft-tissue overshadowings, or due to the abnormal anatomy as in the cleft lip and palate patients or in young children because of the tooth germs molding the anterior contour of the maxilla,\[^6\] in such cases alternative methods have been given by various authors\[^7-9\] to locate this point with acceptable accuracy. However, there are very few studies available in the literature on the reliability of these alternative descriptions and points, and it is not clear whether their use in cephalometric analysis is of any significance.

Since point A location is affected by upper incisor inclination, it is possible that location of alternative points to point A may also be affected by upper incisor inclination. Hence, the null hypothesis was that reliability of alternative points to point A is not affected by the inclination of upper incisors.

The aim of the present study was to test the reliability of these alternative points to Point A given by three different authors in two groups based on the inclination of upper incisors.

### Materials and Methods

#### Data acquisition

Pretreatment lateral head films of seventy patients were selected retrospectively from the department of orthodontics and dentofacial orthopedics, on the basis of excellence of image quality and ability to locate point A with a considerable degree of accuracy, i.e., lateral cephalograms with lack of well-defined anatomic features, outlines, hard edges, and shadows that would have made identification of point A difficult, were not selected. Ethical approval was obtained from Institutional Ethics Committee (ref.no. CODS/2001).

The sample size was determined using G power 3.1.9.2 software (HHU, Dusseldorf, Germany) (effect size-0.8, alpha error-0.05, and power of the study-80%).

The following inclusion criteria were used in selecting patient images:

- Patients above 14 years with fully erupted permanent maxillary anterior teeth
- No missing permanent maxillary incisors
- No unerupted or supernumerary teeth overlying the maxillary incisor apices
- No gross skeletal asymmetry present.

#### Measurements

All lateral head films were viewed under standardized conditions and traced on to acetate overlays with 0.3 mm HB lead pencil by hand by one observer.

The landmarks used and their definition and the variables measured in the study are listed in Tables 1 and 2, respectively.

| Abbreviation | Landmark                  | Description                                                                 |
|--------------|---------------------------|-----------------------------------------------------------------------------|
| N            | Nasion                    | The most anterior limit of the frontonasal suture                           |
| S            | Sella                     | The geometric center of the sella turcica                                   |
| Or           | Orbitale                  | Lowest point on the inferior rim of the orbit                               |
| Po           | Porion                    | Most superiorly positioned point of external auditory meatus                |
| ANS          | Anterior nasal spine      | The tip of the bony anterior nasal spine                                    |
| PNS          | Posterior nasal spine     | The posterior end of the hard palate if visible. Otherwise at the point of intersection of the dorsal maxillary contour and the soft palate contour (Hotz and Gnoinski, 1976) |
| Pr           | Prosthion                 | The point of the maxillary alveolar process in the midline that projects most anteriorly |
| A            | Point A                   | The deepest point on the contour of the alveolar projection between the spinal point and prosthion |
| A1           | Point A alternative 1     | A point plotted 3 mm labial to a point between the upper-third and lower two-thirds of the long axis of the root of the maxillary central incisor (Jacobson and Jacobson\[^9\]) |
| A2           | Point A alternative 2     | Intersection between a line parallel to the palatal plane, 7 mm below, and the anterior contour of the maxilla (Tindlund \textit{et al.}\[^9\]) |
| A3           | Point A alternative 3     | The projection of point Pr on a line parallel to the palatal plane, 7 mm below the palatal plane (Bongaarts \textit{et al.}\[^9\]) |

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Methodology

To test the effect of incisor inclination on reliability of these alternative points to point A, total sample was divided into two groups based on the inclination of maxillary central incisors. Group I consisted of 35 participants with retroclined incisors (U1 to palatal plane [PP] angle of >75°) and Group II consisted of 35 participants with proclined incisors (U1 to PP angle of <65°).

Three alternative methods for estimation of point A suggested in the literature\cite{7-9} were evaluated for reliability in both the groups. Jacobson and Jacobson\cite{7} found a point 3-mm labial to a point between the upper-third and lower two-thirds of the long axis of the root of the maxillary central incisor (estimated point A), to be suitable to draw the NAc line, which most closely approximates the true NA plane, taken as point A1 in this study [Figure 1]. Tindlund \textit{et al.}\cite{8} (1993) suggested a point formed by the intersection of a line parallel to the palatal plane, 7 mm below, and the anterior contour of the maxilla as an alternative for point A, taken as point A2 [Figure 2]. Another alternative to point A was given by Bongaarts \textit{et al.},\cite{9} as a point at the intersection of projection of point prosthion on a line parallel to the palatal plane, 7 mm below the palatal plane which is taken as point A3 in this study [Figure 3].

To assess the reliability of these three alternative points to point A, evaluation was made in two planes, vertical and horizontal. SNA angle [Figure 4] and its comparison with SNA1, SNA2, and SNA3 angles were considered for assessment of reliability in the horizontal plane.

Moreover, projection of point A, A1, A2, and A3 on N perpendicular line\cite{10} was considered and vertical linear comparisons of NA [Figure 5] was made with NA1,
NA2, and NA3 to assess their reliability in the vertical plane.

**Measurement error**

To determine the errors associated with radiographic measurements, 20 radiographs were selected randomly. Their tracings and measurements were repeated 4 weeks after the first measurement and intraobserver reliability was determined using multiobserver Kappa coefficients. Intraobserver reliability ranged from 0.75 to 0.98 for different landmarks suggesting high degree of agreement, with greatest agreement in the location of S, N, and ANS.

**Statistical analysis**

For both Group I and II, mean, standard deviation, and 95% confidence interval of horizontal and vertical parameters were calculated for each of the variables. To compare the means of horizontal and vertical parameters, one-way ANOVA was applied and to determine the specific parameters which deferred from each other, LSD (Least significant difference) post hoc test was done. Pearson’s correlation coefficient was used to assess the strength of association of the alternative points A1, A2, and A3 to point A for both the groups. Intergroup comparison was done using independent t-test. Level of significance was set at $P < 0.05$. All statistical analyses were performed on SPSS 13.0 software (SPSS Inc., Chicago, IL, USA) for windows.

**Results**

Mean, standard deviation, standard error, and 95% confidence interval for each of the horizontal and vertical parameters for both the groups are presented in Table 3. Comparison of the means of all horizontal and vertical parameters for Group I using ANOVA is given in Table 4 which shows a highly significant difference between vertical parameters but nonsignificant difference between horizontal parameters. To further determine specific parameters that differed from each other post hoc test was done [Table 5] which showed a significant difference of SNA3 to SNA and SNA2 and also of NA1, NA2, NA3 with NA. Comparison of the means of all horizontal and vertical parameters for Group II using ANOVA is given in Table 6 which shows a highly significant difference between horizontal parameters and also between vertical parameters. To further determine specific parameters that differed from each other in Group II post hoc test was done [Table 7] which showed highly significant difference of SNA3 with SNA, SNA1, and SNA2. Moreover, among vertical parameters, NA1 significantly differed from NA, NA2, and NA3. Pearson’s correlation test [Table 8] showed highly significant positive correlation of SNA with SNA1, SNA2, and SNA3 in both groups and also of NA with NA1, NA2, and NA3 in Group II. Intergroup comparison using independent t-test showed significant difference of SNA–SNA2 and SNA–SNA3 between both the groups [Table 9].

**Discussion**

An important aspect of cephalometrics in orthodontics is the assessment of sagittal jaw relationship. A pioneering step in the description of the sagittal jaw relationship in orthodontics was the introduction of point A, point B, and A–B plane angle to cephalometrics (1948) by Downs.[5] Thenceforth, several measurements have been given to determine the anteroposterior (AP) relationship of the jaws, most of...
which use point A as a reference point for determination of AP position of the maxilla. However, point A is difficult to locate when anterior anatomy of maxilla is obscured in lateral cephalometric radiographs due to various reasons as already mentioned. It means that in situations where point A is difficult to locate, for such situations alternative methods for point A location have been described in literature by various authors, the reliability of which needs to be thoroughly evaluated. The reliability includes judging location of these alternative points in horizontal and vertical dimensions and relating it to actual location of point A. Thus, in the present study, an attempt has been made to check the reliability of three alternative points to point A. In this study, reliability of three alternative points (A1, A2, and A3) in horizontal plane was evaluated using constructed angles to the SN plane (SNA1, SNA2, and SNA3). To evaluate the reliability in vertical plane, linear measurements of these points from point N was measured and to avoid the error in measurement due to different horizontal position of these points all these points were projected onto a vertical line passing through N and perpendicular to Frankfort Horizontal plane (N perpendicular line).}

Table 3: The sample size, mean, standard deviation, standard error, and 95% confidence interval of all horizontal parameters (degree) and vertical parameters (mm) for both Group I and Group II

|                  | n   | Mean | SD  | SE  | 95% Confidence interval for mean | Minimum | Maximum |
|------------------|-----|------|-----|-----|---------------------------------|---------|---------|
|                  |     |      |     |     | Lower bound                      |         |         |
|                  |     |      |     |     | Upper bound                      |         |         |
| Descriptive table|     |      |     |     |                                 |         |         |
| Group I          |     |      |     |     |                                 |         |         |
| Horizontal parameters |   |      |     |     |                                 |         |         |
| SNA              | 35  | 81.03| 4.30| 0.73| 79.55                           | 82.50   | 71.00   |
| SNA1             | 35  | 81.61| 3.97| 0.67| 80.25                           | 82.98   | 73.50   |
| SNA2             | 35  | 81.33| 4.21| 0.71| 79.88                           | 82.78   | 73.00   |
| SNA3             | 35  | 83.31| 4.24| 0.72| 81.86                           | 84.77   | 76.00   |
| Vertical parameters |   |      |     |     |                                 |         |         |
| NA               | 35  | 57.46| 6.44| 1.09| 55.24                           | 59.67   | 26.00   |
| NA1              | 35  | 61.47| 4.02| 0.68| 60.09                           | 62.85   | 54.50   |
| NA2              | 35  | 60.16| 3.26| 0.55| 59.04                           | 61.28   | 54.00   |
| NA3              | 35  | 60.41| 3.24| 0.55| 59.30                           | 61.53   | 54.50   |
| Group-II         |     |      |     |     |                                 |         |         |
| Horizontal parameters |   |      |     |     |                                 |         |         |
| SNA              | 35  | 82.30| 3.03| 0.51| 81.26                           | 83.34   | 75.00   |
| SNA1             | 35  | 83.19| 3.06| 0.52| 82.13                           | 84.24   | 74.00   |
| SNA2             | 35  | 83.10| 2.86| 0.48| 82.12                           | 84.08   | 77.00   |
| SNA3             | 35  | 87.93| 3.29| 0.56| 86.80                           | 89.06   | 77.50   |
| Vertical parameters |   |      |     |     |                                 |         |         |
| NA               | 35  | 57.43| 3.88| 0.66| 56.10                           | 58.76   | 51.00   |
| NA1              | 35  | 61.73| 4.63| 0.78| 60.14                           | 63.32   | 53.00   |
| NA2              | 35  | 58.77| 3.39| 0.57| 57.61                           | 59.94   | 53.50   |
| NA3              | 35  | 58.94| 3.35| 0.57| 57.79                           | 60.09   | 53.50   |

SD: Standard deviation, SE: Standard error

Table 4: One-way analysis of variance of means of all the horizontal parameters (degree) and of means of all vertical parameters (mm) for Group I

|                  | Sum of squares | df  | Mean square | F   | P   |
|------------------|---------------|-----|-------------|-----|-----|
| Group-I          |               |     |             |     |     |
| Horizontal parameters |           |     |             |     |     |
| Between parameters | 110.01        | 3   | 36.669      | 2.10| 0.104|
| Within parameters | 2380.03       | 136 | 17.50       |     |     |
| Total            | 2490.04       | 139 |             |     |     |
| Vertical parameters |            |     |             |     |     |
| Between parameters | 306.78        | 3   | 102.26      | 5.19| 0.002**|
| Within parameters | 2677.79       | 136 | 19.69       |     |     |
| Total            | 2984.56       | 139 |             |     |     |

*p<0.05 (significant), **p<0.005 (highly significant)
Table 5: Intervariable comparison of all horizontal variables (degree) and all vertical variables (mm) in Group I

| Group-I | Mean difference (I–J) | SE  | Significant | 95% confidence interval |
|---------|-----------------------|-----|-------------|------------------------|
|         |                       |     |             | Lower bound            | Upper bound            |
|         |                       |     |             |                        |                       |
| Horizontal parameters |                       |     |             |                        |                       |
| SNA     |                       |     |             |                        |                       |
| SNA1    | −0.586                | 1.000| 0.559       | −2.563                 | 1.392                 |
| SNA2    | −0.300                | 1.000| 0.765       | −2.278                 | 1.678                 |
| SNA3    | −2.28571*             | 1.000| 0.024*      | −4.263                 | −0.308                |
| SNA     |                       |     |             |                        |                       |
| SNA1    | 0.586                 | 1.000| 0.559       | −1.392                 | 2.563                 |
| SNA2    | 0.286                 | 1.000| 0.776       | −1.692                 | 2.263                 |
| SNA3    | −1.700                | 1.000| 0.091       | −3.678                 | 0.278                 |
| SNA     |                       |     |             |                        |                       |
| SNA1    | 0.300                 | 1.000| 0.765       | −1.678                 | 2.278                 |
| SNA2    | −0.286                | 1.000| 0.776       | −2.263                 | 1.692                 |
| SNA3    | −1.98571*             | 1.000| 0.049*      | −3.963                 | −0.008                |
| SNA     |                       |     |             |                        |                       |
| SNA1    | 1.700                 | 1.000| 0.091       | −0.278                 | 3.678                 |
| SNA2    | 1.98571*              | 1.000| 0.049*      | 0.008                  | 3.963                 |
| SNA3    | 2.28571*              | 1.000| 0.024*      | 0.308                  | 4.263                 |
| SNA     |                       |     |             |                        |                       |
| SNA1    | −1.98571*             | 1.000| 0.049*      | −3.963                 | −0.008                |
| SNA2    | 0.286                 | 1.000| 0.776       | −2.263                 | 1.692                 |
| SNA3    | 2.28571*              | 1.000| 0.024*      | 0.308                  | 4.263                 |
| SNA     |                       |     |             |                        |                       |
| SNA1    | −0.286                | 1.000| 0.776       | −2.263                 | 1.692                 |
| SNA2    | −1.700                | 1.000| 0.091       | −3.678                 | 0.278                 |
| SNA3    | 0.300                 | 1.000| 0.765       | −1.678                 | 2.278                 |
| SNA     |                       |     |             |                        |                       |

*P<0.05 (significant), **P<0.005 (highly significant). SE: Standard error

Table 6: One-way analysis of variance of means of all the horizontal parameters (degree) and of means of all vertical parameters (mm) for Group II

| Group-II | Sum of squares | df | Mean square | F | P, significant |
|----------|----------------|----|-------------|---|--------------|
|          |                |    |             |   |              |
| Horizontal parameters |                |    |             |   |              |
| Between parameters | 690.49         | 3  | 230.16      | 24.51 | 0.000**      |
| Within parameters  | 1276.89        | 136| 9.39        |      |              |
| Total            | 1967.38        | 139|             |      |              |
| Vertical parameters |                |    |             |   |              |
| Between parameters | 342.31         | 3  | 114.10      | 7.71 | 0.000**      |
| Within parameters  | 2011.80        | 136| 14.79       |      |              |
| Total            | 2354.11        | 139|             |      |              |

*P<0.05 (significant), **P<0.005 (highly significant). SE: Standard error

Since point A location is affected by the upper incisor inclination,$^{11,12}$ reliability of location of alternative points A1, A2, and A3 could be affected by proclination/retroclination of upper incisors. To check this, the sample was divided into two groups based on the upper incisor inclination – Group I – retroclination group and Group II – proclination group. To reduce the
magnification error, all the radiographs were taken from same X-ray machine.

**Reliability within the groups**

**Evaluation in horizontal plane**

In this study, point A3 was found to be least reliable in horizontal plane in both the groups [Table 5 and Table 7]. Reason being, the authors\(^9\) have used prosthion point for determination of horizontal position of point A and since prosthion is the most anteriorly projected midline point of the maxillary alveolar process, its position is affected by the inclination of maxillary central incisors. Thus, reliability of point A3 is affected most by the inclination of incisors compared to other two, making it least reliable alternative point. A1 and A2 can be used as an alternative to point A in horizontal plane but among the two, point A2 can be considered more reliable as the mean difference between SNA–SNA2 was found to be least [Figure 6] as well as its correlation coefficient was found to be highest in both the groups [Table 8].

**Evaluation in vertical plane**

In vertical plane, all three alternative points were found unreliable in Group I with point A1 being least reliable among the three with highly significant mean difference with NA [Table 5]. In Group II (proclination group) A1 was found to be least reliable with highly significant difference of NA1 with NA, NA2, and NA3 [Table 7]. Thus, the result of this study showed point A1 to be least reliable in vertical plane in both the groups. The reason could be that author\(^7\) has considered root length of central incisor as a reference for determining the position of point A in vertical plane. Although horizontal position of point A is dependent on the inclination of

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**Table 7: Intervariable comparison of all horizontal variables (degree) and all vertical variables (mm) in group II**

| Group-II | Mean difference (I–J) | SE       | Significant | 95% confidence interval | Lower bound | Upper bound |
|----------|-----------------------|----------|-------------|-------------------------|-------------|-------------|
|          |                       |          |             |                         |             |             |
| Horizontal parameters |                       |          |             |                         |             |             |
| SNA      |                       |          |             |                         |             |             |
| SNA1     | −0.886                | 0.732    | 0.229       | −2.334                  | 0.563       |
| SNA2     | −0.801                | 0.732    | 0.276       | −2.250                  | 0.647       |
| SNA3     | −5.62857**            | 0.732    | 0.000**     | −7.077                  | −4.180      |
| SNA1     |                       |          |             |                         |             |             |
| SNA2     | 0.886                 | 0.732    | 0.229       | −0.563                  | 2.334       |
| SNA3     | 0.085                 | 0.732    | 0.908       | −1.364                  | 1.533       |
| SNA3     | −4.74286**            | 0.732    | 0.000**     | −6.191                  | −3.294      |
| SNA1     |                       |          |             |                         |             |             |
| SNA2     | 0.801                 | 0.732    | 0.276       | −0.647                  | 2.500       |
| SNA3     | −0.085                | 0.732    | 0.908       | −1.533                  | 1.364       |
| SNA3     | −4.82743**            | 0.732    | 0.000**     | −6.276                  | −3.379      |
| SNA1     |                       |          |             |                         |             |             |
| SNA2     | 5.62857**             | 0.732    | 0.000**     | 4.180                   | 7.077       |
| SNA3     | 4.74286**             | 0.732    | 0.000**     | 3.294                   | 6.191       |
| SNA2     | 4.82743**             | 0.732    | 0.000**     | 3.379                   | 6.276       |

Vertical parameters

| NA      |                       |          |             |                         |             |             |
|---------|-----------------------|----------|-------------|-------------------------|-------------|-------------|
| NA1     | −4.30000**            | 0.9194   | 0.000**     | −6.118                  | −2.482      |
| NA2     | −1.34286              | 0.9194   | 0.146       | −3.161                  | 0.475       |
| NA3     | −1.51429              | 0.9194   | 0.102       | −3.332                  | 0.304       |
| NA1     |                       |          |             |                         |             |             |
| NA2     | 4.30000**             | 0.9194   | 0.000**     | 2.482                   | 6.118       |
| NA3     | 2.95714**             | 0.9194   | 0.002**     | 1.139                   | 4.775       |
| NA3     | 2.78571**             | 0.9194   | 0.003**     | 0.968                   | 4.604       |
| NA2     |                       |          |             |                         |             |             |
| NA1     | 1.34286               | 0.9194   | 0.146       | −0.475                  | 3.161       |
| NA3     | −2.95714**            | 0.9194   | 0.002**     | −4.775                  | −1.139      |
| NA3     | −0.17143              | 0.9194   | 0.852       | −1.990                  | 1.647       |
| NA1     |                       |          |             |                         |             |             |
| NA2     | 1.51429               | 0.9194   | 0.102       | −0.304                  | 3.332       |
| NA1     | −2.78571**            | 0.9194   | 0.003**     | −4.604                  | −0.968      |
| NA2     | 0.17143               | 0.9194   | 0.852       | −1.647                  | 1.990       |

*P<0.05 (significant), **P<0.005 (highly significant). SE: Standard error
vertical position of point A is affected by position of ANS, which forms the anterior limit of the palatal plane. A2 and A3 can be used as an alternative to point A in vertical plane, but among the two, point A2 can be considered more reliable as the mean difference between NA–NA2 was found to be least [Figure 7] as well as its correlation coefficient was found to be highest in both the groups [Table 8].

Thus in this study, point A2 was found to be most reliable in both vertical and horizontal plane. As it is known that the position of point A is affected by the inclination of palatal plane anteriorly, the fact that Tindlund et al.[8] used palatal plane as a reference to determine location of point A in vertical plane could be a reason for its high reliability in vertical plane. Furthermore, the use of anterior contour of maxilla as reference for horizontal location, made point A2 most reliable even in horizontal plane. Hence, point A2 can be used as a reliable alternative to point A in both horizontal and vertical direction. But for location of point A2, anterior contour of maxilla should be clearly visible. Those situations where anterior contour of maxilla is not distinctly visible in lateral cephalograms, point A1 can be used as an alternative to point A instead of A2 for drawing a line NA1 which will very closely approximate the actual NA line and thus for determining sagittal jaw relationship as A1 is reliable alternative point in horizontal plane.

### Intergroup comparison

Intergroup comparison [Table 9] shows that reliability of point A1 is not affected by the incisor inclination, but the reliability of point A2 and A3 in horizontal plane differed significantly in both the groups. Furthermore, it seems that the reliability of these alternative points is affected by inclination of incisors only in horizontal plane and not in vertical plane. As point A is mainly used in cephalometrics for determination of sagittal jaw relationship, the reliability of these two alternative points to point A in horizontal plane is of more importance for orthodontics and since the mean difference was less in Group I then in Group II for these alternative points [Table 9], it shows that these points are more reliable in patients

### Table 8: Correlation coefficient for comparison of all three alternative parameters to original parameter for both the groups

| Parameters   | Group-I   | Group-II  |
|--------------|-----------|-----------|
| Horizontal   | SNA1      | SNA2      | SNA3      |
| SNA          | Pearson correlation: 0.983** 0.988** 0.926** | Significant (two-tailed): 0.000 0.000 0.000 |
| Vertical     | NA1       | NA2       | NA3       |
| NA           | Pearson correlation: 0.392* 0.463** 0.330 | Significant (two-tailed): 0.020 0.005 0.053 |
|              | n         | 35        | 35        | 35        |

### Table 9: Intergroup comparison using independent t-test

| Parameters   | Mean difference | t     | P, significant |
|--------------|-----------------|-------|---------------|
| Horizontal   | SNA-SNA1        |       |               |
| Group-1      | 0.586           | 1.044 | 0.300         |
| Group-2      | 0.886           |       |               |
| SNA-SNA2     |                 |       |               |
| Group-1      | 0.300           | 2.176 | 0.033*        |
| Group-2      | 0.801           |       |               |
| SNA-SNA3     |                 |       |               |
| Group-1      | 2.285           | 7.599 | 0.000**       |
| Group-2      | 5.628           |       |               |
| Vertical     | NA-NA1          |       |               |
| Group-1      | 4.014           | 0.259 | 0.796         |
| Group-2      | 4.300           |       |               |
| NA-NA2       |                 |       |               |
| Group-1      | 2.700           | −1.345| 0.183         |
| Group-2      | 1.342           |       |               |
| NA-NA3       |                 |       |               |
| Group-1      | 2.957           | −1.329| 0.188         |
| Group-2      | 1.514           |       |               |

*P<0.05 (significant), **P<0.005 (highly significant)
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with retroclined incisors then with proclined incisors. Thus, it can be said that determination of sagittal jaw relationship using point A2 and A3 in patients with retroclined incisors will approximate more closely to actual value as compared to patients with proclined upper incisors. However, further studies need to be done with larger sample size and digitalized recording devices to have a clearer picture on the reliability of these points.

CONCLUSION

1. Point A3 is the least reliable alternative to point A in both the groups for determination of sagittal jaw relationship
2. Point A2 is the most reliable alternative to point A in both the groups, in horizontal as well as vertical planes
3. Situations where anterior contour of maxilla is obscured in lateral cephalograms, point A1 can be used as a reliable alternative to point A to determine sagittal jaw relationship
4. Horizontal reliability of alternative points A2 and A3 is affected by the inclination of incisors with these points being more reliable in patients with retroclined incisors as compared to patients with proclined upper incisors.

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Conflicts of interest
There are no conflicts of interest.

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