

The Third-Order Angle and the Maxillary Incisor's Inclination to the NA Line: A custom made TIP appliance

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ABSTRACT

Aim: Aim of this study is to evaluate relationship between: 1. Angular measurement data (U1-NA) from lateral ceph& upper incisor 3rd order angle

Materials & method: TIP device can be used to determine the angulation of cuspids, bicuspid and molars on dental casts. It can be used intra-orally also and helps in assessing incisor inclination in pre- mid- and post-treatment

Results: The relationship between the two can be defined by Regression equation (GALTON 1877) $Y = 1.53X - 10.67$, Where Y is the cephalometric value U1 to NA and X is the UI to NA measured by TIP.

Keywords: TIP appliance, incisor inclination, third order angle.

INTRODUCTION

The specialty of Orthodontics has evolved over the last century as the combination of science, engineering and art. Our credentials are based on delivering the three basic principles that clearly enumerate our services into our goals as Form, Function and esthetic. The pleasant smile which is the primary motivation behind undertaking this treatment is only possible by perfect placement of the six maxillary anteriors according to the facial types, thus the need for defining the inclinations of the maxillary anteriors becomes a value of paramount importance. For reasons of both function and esthetics it is therefore important to assess incisor inclination before, during and at the end of the orthodontic treatment. Accurate measurements of hard tissue relationships are possible only with the aid of radiographs. According to Baumrind & Frantz (1971)¹ and Houston (1983)²

radiographically determined axial inclination of the incisors has a great degree of error and also exposure of patient to x-rays carry small but quantifiable amount of risk as dental radiography contributes to about one third of all medical exposure.

The use of gauges has been used as an alternative to radiograph to measure the incisor inclination and vertical jaw relation directly from the patient or from study models. Maxillator by Salzmann, Incisal angulation by Carey and Carlsson and Ronnerman's³ device for measuring incisor inclination, are a few examples of gauges used in the past. According to many researchers the clinical method for measuring incisor inclination must be based upon the crown, the labial surface of which is easiest to visualize. The use of most cephalometric analyses for determination of the incisor's axial inclination presents the orthodontists with the

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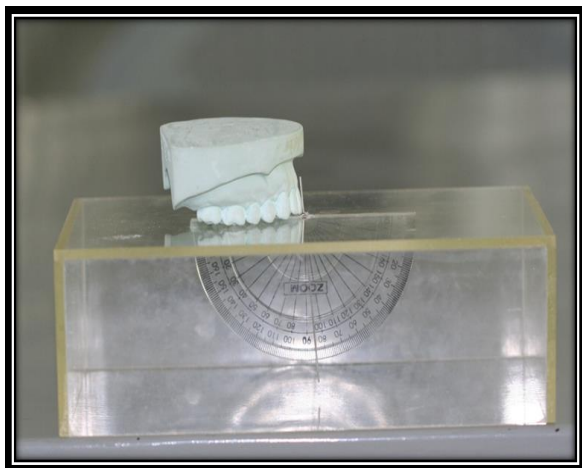


Fig 1: Custom made TIP appliance.

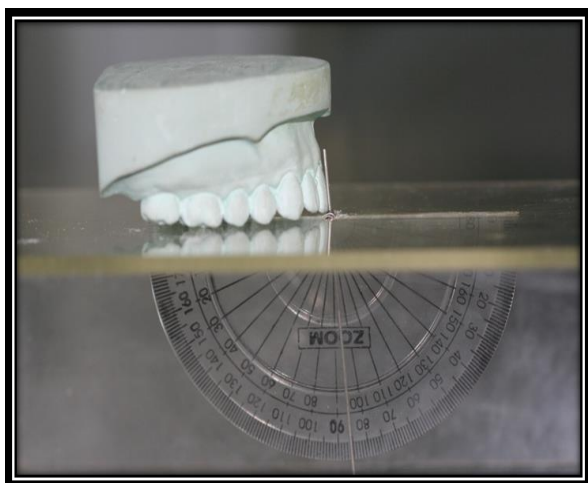


Fig 2: Custom made tip appliance.

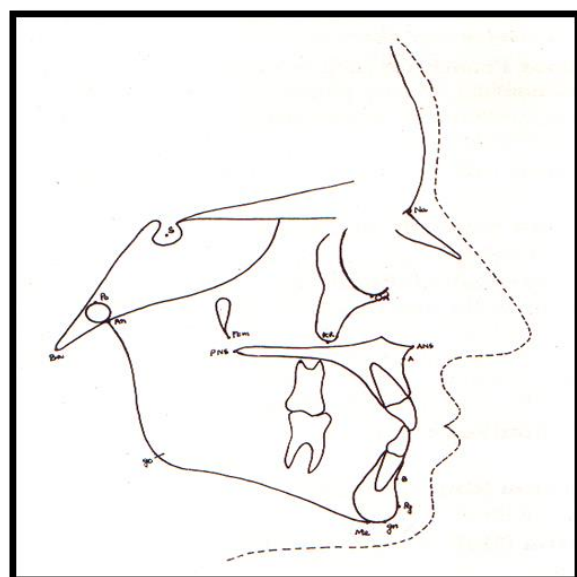


Fig 3: Angular measurement used in study.

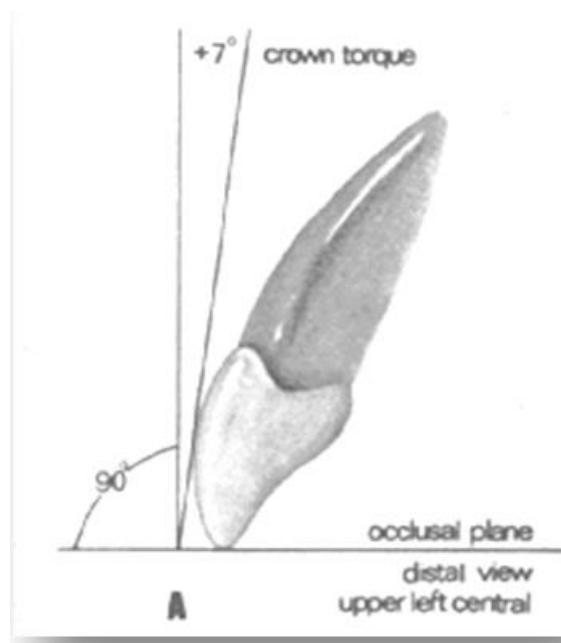
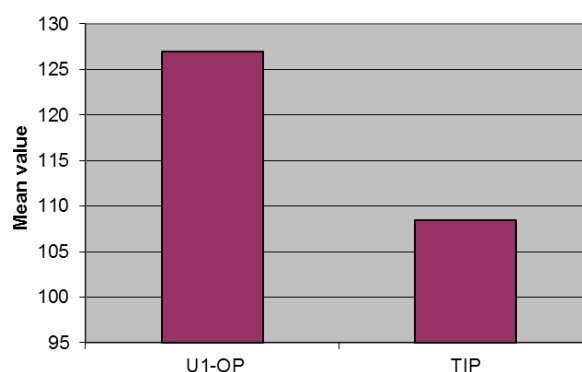


Fig 4: TA angle formed by a perpendicular to the occlusal plane and a line that is tangent to the middle of the labial long axis of the clinical crown.



Graph 1: comparison of mean between u1-op and tip.

difficulty of relating the assessed data to the third order prescription of brackets used in Pre-adjusted Edgewise Appliances. Third order bracket prescription in Pre-adjusted Edgewise Appliance refers to a perpendicular to Andrew's occlusal plane and Andrew's facial axis of clinical crown (FACC) which are different reference lines than the reference planes being used to assess long axis of the Maxillary central incisor cephalometrically in the radiographs.

The purpose of the present study is to quantify the relationships between the angular measurements i.e. Maxillary incisor's long axis to N-

A Line (in the radiograph) and the Third order angle according to Andrew's description (on the dental cast) with no exposure to x-ray.

Table 1: Correlations of U1-sn and tip measurements.

Parameter	Mean	SD	Mean deviation	Std Deviation	Correlation r	p
U1-SN	118.73	2.841	12.8	1.459	0.87*	0.000
TIP	108.41	3.017				

**correlation is significant at the 0.01level

Table 2: Linear regressions for SN-OP with the following variables.

*statistical significance at the 0.05 level,

Variable	r	r ²	Standard error	P
U1-OP	0.973**	0.947	0.751	0.000
U1-SN	0.753**	0.567	1.159	0.000

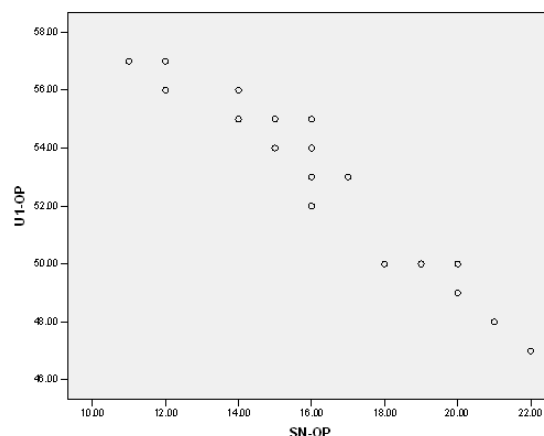
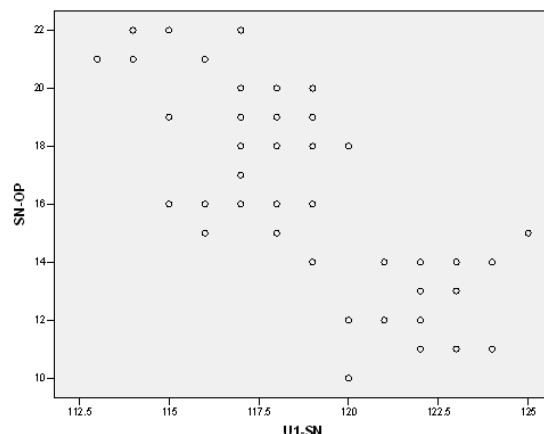
significance at the 0.01 level, *significance at the 0.001 level.

Table 3: Correlations between U1-OP and tip.

Variable	Mean	SD	Mean deviation	SD	Standard error mean	r	P
U1-OP	126.92	3.470	18.51	1.984	.248	0.82**	.000
TIP	108.41	3.017					

MATERIALS & METHOD

A study was carried out in the Department of Orthodontics and Dentofacial Orthopedics, Meghna institute of dental sciences, Nizamabad, with the purpose of evaluating the use of a valid, reliable, simple, inexpensive and non-invasive method to record maxillary central incisor inclination and compare it with the derived angulations from the traditional lateral cephalogram. The data was collected from the patients visiting the department.



Graph 2: Scattered diagrams for correlations of sn-op with U1-OP and U1-OP.

The sample of 40 subjects was randomly selected from the records available in the department on the basis of the following criteria:

- All the subjects were in the age group of 15 – 25 years.
- None of the subjects had any history of previous orthodontic treatment.
- None of the subjects had any obvious cranio-facial malformations.
- No attrition in relation to maxillary and mandibular incisors.
- Curve of Spee shouldn't exceed more than 3.5 mm

CUSTOM MADE TOOTH INCLINATION PROTRACTOR (TIP APPLIANCE)

In our study we used a custom made TIP appliance in order to reduce the cost.(fig 1,2) a platform was made of a fiber glass slab, to which the protractor was attached below . A slit had been made in the glass for adjustment of the inclination arm so that it could be extended or shortened to lie against the labial surface of the incisor crown to allow for anatomical variations in crown height. Appliance similar to appliance used in study of Ghahferokhi⁵

METHOD

Standardized lateral cephalometric radiographs, selected treatment parameters were analyzed. These included angular measurements (1NA/ deg, SNA, SNB, ANB, NSL-NL, NSL-ML, ML-NL) and linear measurements (1NA/mm). These were performed after identifying 10 landmarks (sella, nasion, A, B, tip and root apex of the most proclined upper incisor, anterior nasal spine [ANS], posterior nasal spine [PNS], menton, and most inferior point on the outline of the mandible at the gonion angle). The acquired data were compared with Andrews' third-order angle (TA), derived from direct dental cast measurements of the most proclined upper incisor (1TA)

TA assessed using an incisor inclination recording device (TIP appliance). The maxillary dental casts were positioned on a table-tracked sledge by contacting molars and bicuspid in order to maintain the occlusal plane. After marking of the middle of the labial long axis of the incisor's clinical crown (LACC), the upper incisor was adjusted with its edge parallel to the sledge's front side and was then guided forward against a straight wire until it touched the LACC. The wire's excursion marks the inclination of the incisor's facial surface to the occlusal plane according to Andrews' description

The measured 1TA data were defined as positive if the gingival portion of the facial tangent represented by the wire was lingual to the incisal portion.

Following landmarks are recorded on the lateral cephalometric radiographs:

- Sella Turcica (S)
- Nasion (Na)
- Gonion (Go)

- Gnathion (Gn)
- Point A
- Long axis of central incisor- line formed by joining the midpoint of incisal edge and root apex of the most proclined central incisor.

The angular measurements undertaken were-

1. U1-NA (upper incisor to NA) - is the angle formed by the long axis of the incisor to the line connecting the Nasion to point A is measured.
2. U1- OP (upper incisor to occlusal plane) - is the angle formed by the long axis of upper incisor to the occlusal plane which is drawn through the overlapping cusps of the first premolars and first molars.
3. SN-OP - the angle formed between SN line and occlusal plane.
4. U1-SN - the angle between upper incisor to SN plane.

RESULTS

The present study was designed to compare and correlate the incisor inclination measured by lateral cephalometric radiographs with that of the third order angle measurement on dental casts. A total of 40 subjects were selected for the study. All of them fulfilled the criteria's for selection. Cephalometric angular measurements evaluated in this study were -U1-NA, U1-OP, U1-SN and SN-OP, Dental cast measurement included third order angle measured by device tooth inclination protractor. The mean values for each parameter studied along with the mean paired differences and standard deviation of paired differences and pearson correlation coefficient for the axial inclination and third order angle are depicted in table 1 and graph 1.

In our sample there was a mean difference of 12.8 between pretreatment U1-SN and TIP with a significant correlation of $r=0.87$. At the end of the treatment there was a similar mean difference of 10.57 between the two parameters.

The torque angle measurements derived from casts were smaller by a mean of 12.8(SD= 1.49) than the axial inclination measurements in reference to SN plane derived from the lateral cephalograms. The regression analysis illustrated

the relationship and significant coefficient of correlation ($p < 0.001$) between the cant of occlusal plane (SN-OP) and U1-OP where $r = 0.97$ as shown in table 2. A mean difference of 18.51 degrees was found between the TIP scores and equivalent radiographic scores (U1-OP) with a standard deviation of 1.98 degrees ($r = 0.82$) as depicted in table 3

DISCUSSION

The purpose of this study was to investigate the relationship between the axial inclination of upper incisor, as estimated by angular measurements in reference to SN plane, and the third order angle described by Andrews. Faciolingual torque expressed on the crown of anterior teeth positions them for optimal dental occlusion. Presumably torque also positions the roots to best withstand the forces of occlusion.

Knösel ⁴ et al also found a strong correlation of 0.84 between incisors long axis and third order angle, although another cephalometric plane i.e. U1-NA has been used. This study is similar to the study conducted by Ghahferokhi ⁵ et al as in both the studies there exists no difference between the two values (mandibular incisors inclination) and there exists high positive correlation between the two.

Ross⁶ et al evaluated faciolingual inclinations based on occlusal table inclinations relative to occlusal plane. He found significant differences in the inclination of the upper incisor relative to occlusal plane (U1-OP) and inclination of the occlusal plane relative to sella-nasion plane (SN-OP) among three different vertical skeletal growth patterns. In the present study, a highly significant correlation existed ($r = 0.92$) between the SN-OP and U1-OP. As the occlusal plane increases there is a corresponding decrease in the upper incisor to occlusal plane. This means that variation in SN-OP angle will cause a straight wire to create very large mean differences in the upper incisor position relative to SN plane.

When SN-OP angle varies from the average values, the differential moments created are capable of producing tooth positions that are markedly different from those intended by SWA prescription. Since the torque prescription of SWA are

preadjusted relative to the occlusal plane, therefore realization of torque potential will result in reorientation of incisor bracket to SN. In case of a labially proclined teeth and high occlusal plane angle, this tooth inclination protractor (TIP) device can be used intraorally to determine the torque prescription of bracket in order to achieve proper inclination of that particular tooth. Because this device relates the facial axis to the occlusal plane it gives better assessment of third order angle and hence the torque prescription. When there is a variation in the facial surface contour of the tooth, this tooth inclination protractor device can be of use to measure the facial axis inclination and torque requirement of that tooth after locating the LA point on that particular tooth.

In the present study, statistically significant relationship existed between the long axis of maxillary incisor and the facial axis centre of clinical crown ($r = 0.82$) and there is a mean difference of 18.5° with a standard deviation of $\pm 1.9^\circ$. The use of lateral cephalograms for assessing axial inclination is based on the assumption that a line connecting the apex and the incisal edge reflects the long axis of the tooth, but in some cases there is a difference between the crown and the root's long axis, especially in Class II/2 cases. Because Andrews' third-order angle considers the labiolingual crown inclination regardless of the root's inclination or the inclination of the long axis of the entire tooth, there might be a gap between the two measurements. A tooth that appears to be proclined on the lateral cephalogram might show a retroclined crown on the dental cast. In the present study, a statistically significant relationship existed between the upper incisor to SN plane and the third order angle (TIP) value with a standard deviation of $\pm 1.45^\circ$. The TIP tended to record the maxillary incisor inclination with almost same mean difference to U1-SN plane (12.8).

In terms of clinical implication, whenever a torque measurement needs to be assessed during the treatment procedure, an impression can be taken and poured. With the help of this device the third order angle can be directly measured from the cast which can be correlated with the cephalometric reading rather than exposing the patient to radiation. The tooth inclination protractor (TIP) is a simple, non-invasive and quick technique to assess

incisor inclination. It can be used to record changes in the incisor inclination during the treatment. In this study the mean scores of the upper central incisors were obtained from the TIP as the readings are given in a range and compared with the radiographically determined values. There is a problem in assessing the validity of the TIP to a precision level of one degree since the equipment gives the accuracy of upto ± 5 degrees. In order to obtain accurate reading of torque prescription of a particular tooth a more precision device which gives to the precision of 0.5 or 1 degree variation needs to be fabricated and used.

SUMMARY AND CONCLUSION

The conclusions of the study were-

1. The tooth inclination protractor (TIP) is a fairly reliable and valid tool for assessing maxillary incisor inclination and the TIP may be used to record changes of incisor inclination during treatment.
2. A statistically significant correlation existed between the upper incisor to SN plane and the third order angle (TIP) value. The TIP consistently underscores the lateral cephalometric radiographic determined maxillary incisor inclination by 12.8 degrees.
3. A significant correlation was found between the cant of occlusal plane and maxillary incisor inclination and according to which torque prescription of bracket can be determined.
4. Third order measurements using TIP device can offer a simple way to get an objective and rapid vision of the incisors inclination and might be a helpful guideline to the choice of low or high torque brackets.
5. Direct dental cast measurements appear to be more precise and more valuable than lateral

radiographs, as the remaining torque potential of brackets and wires during treatment can be better estimated.

6. The tooth inclination protractor device can be used during the treatment to evaluate torque expression of a particular tooth thereby eliminating periodic exposure of the patient to radiation.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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