Journal of Oral Health & Dentistry
JOHD, 3(1): 179-184
www.scitcentral.com

ISSN: 2638-499X

Review Article: Open Access

3D Planning Strategies of Maxillary and Mandibular Incisor Position before Starting the Orthodontic Treatment

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Received July 26, 2019; Accepted September 13, 2019; Published February 27, 2020

ABSTRACT

Introduction: With many advances in orthodontic and surgical techniques, more focus has shifted toward the incisors position planning as a starting point. Today, instead of using the molars as a starting point, the incisor position based treatment planning is possible. Then the treatment mechanics can be planned to position the incisors ideally, around which all the other teeth will fit subsequently. Controlled upper incisor tooth movement is needed to achieve the treatment goal. It is helpful to consider the upper arch in isolation when planning treatment mechanics to position the upper incisors at planned position. The purpose of this article therefore is to emphasize the key aspects of diagnosis and treatment planning of incisor positioning in all the three plane of spaces.

Conclusion: The majority of the orthodontic cases require changes in incisor position. It is helpful first to plan the upper incisor corrections and second to plan the lower incisor corrections. Having decided on an incisor position for a case will allow more clear and systemized organization of treatment mechanics.

Keywords: 3D planning, Incisor position, PIP

INTRODUCTION

In late 1920s Angle introduced his classification which was primarily focused on molar relationship. In that period the treatment of choice was generally non-extraction and expansion. In 1940s, Tweed [1] emphasised more on extraction treatment plan and his concern was more on lower incisors position. At that time surgical correction or functional appliance was not available therefore there was more emphasis on the lower incisors, with minimized emphasis on the upper incisors [1]. Today, treatment planning can be done on the position of the upper incisors, instead of using the molars or the lower incisors as a starting point. At the start of treatment planning, it is possible to envision an 'ideal' position for upper incisors [1].

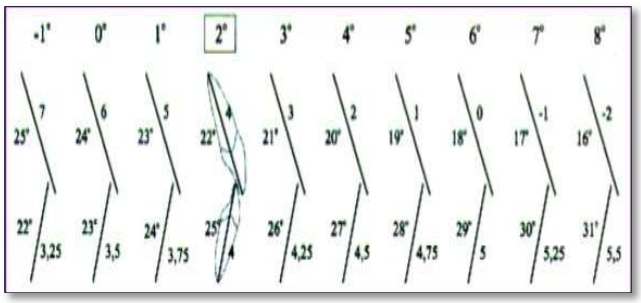

Figure 1. Steiner's sticks.

ANTERO-POSTERIOR PLANE

Steiner's sticks

The basal discrepancies are compensated by position of the teeth and if there is not adequate compensation of these discrepancies the position of incisors influences the position of lips.

Steiner's expressed the sagittal relation of the jaws by using ANB angle.

According to him the position of upper and lower incisors changes as ANB angle changes **(Figure 1)**.

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Citation: Jain S, Vibhute P, Patil C, Umale V, Balagangadhar, et al. (2020) 3D Planning Strategies of Maxillary and Mandibular Incisor Position before Starting the Orthodontic Treatment. J Oral Health Dent, 3(1): 179-184.

For 1 degree change in ANB angle 1 mm and 1 degree change in upper incisors-NA and 0.25 mm and 1 degree for lower incisor-NB is seen.

Steiner acceptable compromises indicate how it is possible to adjust the position of the upper and lower incisors to the size of the ANB angle and at the same time maintain a normal over jet and overbite. Find the position of the incisor that best compensates a basal sagittal discrepancy which is only indicated with positive ANB angle [1,2].

Planned incisor position

Definition of PIP: The intended end of treatment position for upper incisors **(Figure 2)**.

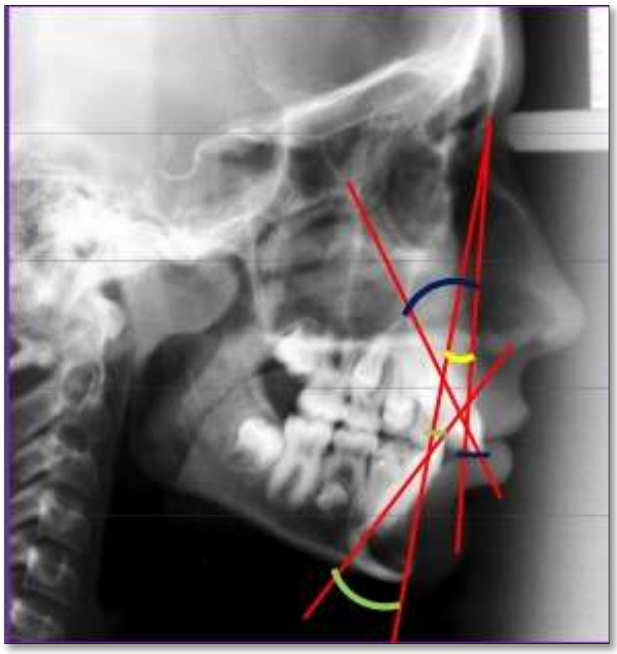

Figure 2. Planned incisor position (PIP).

How the PIP is determined for a case?

For determination of PIP three questions should be asked:

- What is the ideal position for the upper incisors in the face in terms of A/P position, torque and vertical positioning?
- Can ideal upper incisor position be achieved?
- If not, can an acceptable incisor position be achieved by orthodontics alone or is it necessary to consider maxillary surgery?

In such a way, for a case PIP is determined.

Realistic treatment goal changes from case to case. In some cases, perceived ideal upper incisor position can become PIP whereas in other cases the perceived ideal position of incisors has to be compromised. These cases include less cooperative patients or patients with less growth potential. Then a PIP has to be accepted which is not ideal, but which is acceptable for the case [1].

Anchorage need: By comparing the starting position of upper and lower incisors with PIP at the end of treatment the anchorage control needs of a case can be determined. It can be determined early in the treatment. During tooth leveling and aligning, the anchorage control should be managed to ensure that the upper and lower incisors either show no change or they should move favorably relative to PIP. Ideally, throughout leveling and aligning incisor movement should be favorable, relative to PIP; so that the amount of tooth movement needed later in the treatment will be reduced.

A/P changes are most commonly concerned, but torque control and vertical issues need to be considered as well and properly managed, where appropriate.

Dental VTO can be used to predict the anchorage needs for the molars and canines. These teeth should show no change, or preferably favorable change, relative to the VTO requirements. Every orthodontic case will be different, and the anchorage control needs will be determined by the position of the incisors relative to PIP and not by the Angle's classification of the molars [3,4].

PIP components in class II cases

The four-stage treatment planning process.

During treatment planning, these four stages should be considered:

Stage 1 - Setting a PIP for the upper incisors

Stage 2 - The lower incisors

Stage 3 - The remaining lower teeth

Stage 4 - The remaining upper teeth

Treatment for each case, in the upper incisors for having correct A/P and vertical positioning with appropriate torque it is necessary to set a PIP as a treatment goal.

It consists of 3 components:

- A/P component
- Torque Component
- Vertical Component

A/P component: The upper incisor A/P position in relation to the A-Po line has a conventional cephalometric value of +6 mm. In Arnett analysis the upper incisor position to a True Vertical Line (TVL) is measured, in which the linear measurement from the lip of the upper incisor to the true vertical line is calculated. The male upper central incisor tip is ideally -12 mm to the line and the female is at -9 mm [5-7].

Torque component: Traditionally in orthodontics upper incisor torque has been related to the maxillary plane, with a cephalometric value of 110° to 115° being a typical goal. The Arnett analysis relates upper incisor torque to the maxillary occlusal plane and lower incisor torque to the mandibular occlusal plane [5-7].

The male upper central incisor torque being ideally 58° and the female 57°.

PIP components in class III cases

The four-stage treatment planning process.

During treatment planning of class III cases, these four stages should be considered:

Stage 1 - Setting a PIP for the upper incisors

Stage 2 - The lower incisors

Stage 3 - The remaining upper teeth

Stage 4 - The remaining lower teeth

This involves deciding what would be the ideal position for the upper incisors. Is this achievable? If not, can orthodontic tooth movements be used to reach a position which is less than ideal, but acceptable? Or will maxillary surgery be needed to reach an acceptable upper incisor position? In this way, a PIP (planned incisor position) for the upper incisors can be established.

The first stage in Class III treatment planning concerns upper incisor position. It is necessary to determine an ideal position and then decide whether it can be achieved. If not, a modified position may be appropriate, which is less than ideal, but acceptable. In this way a 'planned incisor position' or PIP, is determined.

The second stage of treatment planning involves positioning of the lower incisors. This is frequently a key concern in Class III cases with mandibular excess. The answer may be 'possibly, but there is concern about future growth, and it is preferable to wait for this to express itself'.

The third stage in Class III treatment planning involves deciding on treatment mechanics to position the rest of the upper teeth correctly to fit the PIP for the upper incisors. The dental VTO will confirm the required movement of molars and canines.

The final stage of Class III treatment planning includes assessment of lower arch crowding or spacing and decide how to position the rest of the lower teeth to fit the planned lower incisor position.

In some Class III marginal extractions case, second molars may be considered **(Table 1)**.

Table 1. PIP components.

	PIP (At start of treatment)	A/P anchorage control	Use of lace backs and bend backs
Class11/1 example	The upper incisors are normally in front of PIP	Full A/P anchorage control will be required	Required (may require support from a palatal bar, a headgear or Class II elastics)
Class III example	The upper incisors are behind PIP (although in other Class III cases they may be on PIP or even in front of it)	Upper arch - Anchorage control will only be needed if there is a risk of overproduction of the upper incisors, beyond the PIP	Upper arch - Contraindicated Lower arch - Required possibly supported with a lingual arch and/or Class III elastics
Bimaxillary protrusion example	Upper and lower incisors will be in front of PIP	Full anchorage control will be required in both arches	Required
Bimaxillary retrusion - a Class 11/2 example	Upper and lower incisors will be behind PIP	Not difficult to manage in anchorage terms	Can be used so that anterior bracket tip can express itself

Facial tetragon

Fastlight in June 2000, presented a discussion on the facial 'tetragon' consisting of four angles **(Figure 3)** [4].

- Upper incisor to palatal plane
- Lower incisor to mandibular plane
- Inter-incisal angle

- Maxillary/mandibular plane angle

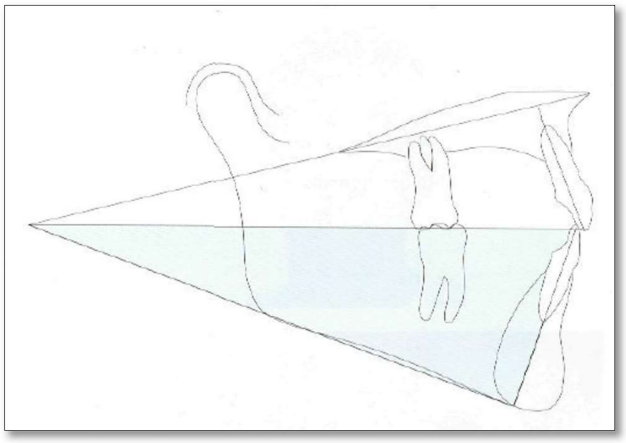

Figure 3. Facial tetragon.

By dividing the tetragon in half, two triangles are formed.

The upper triangle has angles as follows **(Figure 4)**:

1. Palatal plane to occlusal plane
2. Upper incisors to palatal plane
3. Upper incisors to occlusal plane

The lower triangle has angles as follows **(Figure 5)**:

1. Mandibular plane to occlusal plane
2. Lower incisors to occlusal plane
3. Lower incisors to mandibular plane

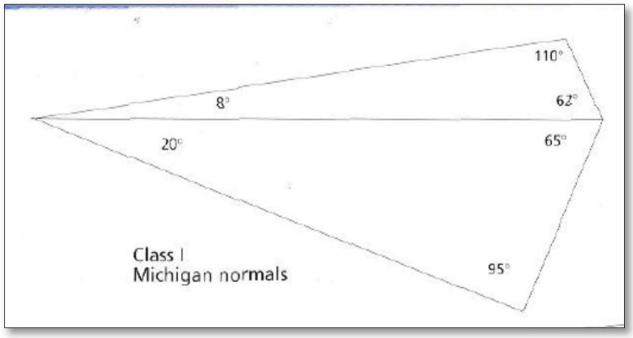

Figure 5. Upper triangle.

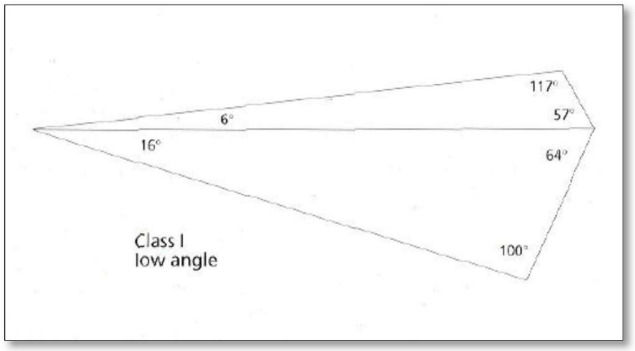

Figure 5. Low angle.

Envelope of discrepancy

The maximum amount of movements possible by three different means of treatment is given by Epker envelope discrepancies. The perimeter of each envelope gives the maximum range of movements possible by different methods of treatment. The three envelopes given by Epker are described in **Table 2**.

Table 2. Three envelopes of Epker.

Inner envelope	Only orthodontic treatment
Middle envelope	Orthodontic and growth modification
Outermost envelope	Orthognathic surgery

The potential for retraction is more than proclination of teeth. The growth modification envelope for the two jaws is the same as the growth of maxilla cannot be modified independently of mandible. The Surgery to move the lower jaw back has more potential than surgery to advance it **(Figures 6 and 7)** [8-11].

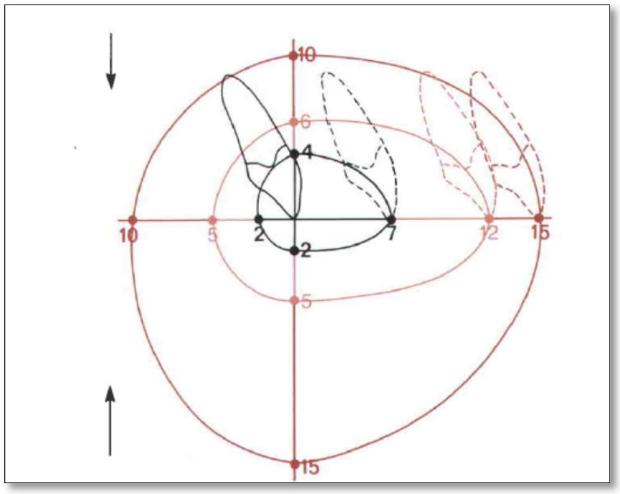

Figure 6. Growth modification envelope for the upper jaw.

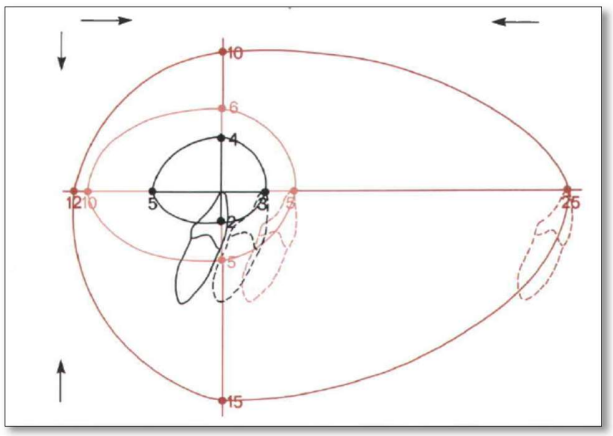

Figure 7. Growth modification envelope for the lower jaw.

Vertical plane

Planned incisor position: PIP components in Class II cases.

Treatment for each case, in the upper incisors for having correct A/P and vertical positioning with appropriate torque it is necessary to set a PIP as a treatment goal.

It consists of 3 components:

- A/P component
- Torque component
- Vertical component

The Arnett analysis calculates the vertical positioning of upper incisors. In this analysis an overbite of 3 mm is required, upper incisor exposure should be 4 mm below the relaxed upper lip in males and 5 mm in females. In class 11/2 malocclusion cases the high lip line is a contributory factor. In such cases there is a need to procline and intrude upper incisors to assist in stability.

Envelope of discrepancy

The ideal position of the upper and lower incisors has shown by the origin of the x and y axes. There is more potential for extrusion (correction of open bite) than intrusion (correction of deep bite). The growth modification envelope for the two jaws is the same as the growth of maxilla cannot be modified independently of mandible. The potential of surgery to extrude is more than surgery to intrude **(Table 3)** [9-11].

Table 3. Potential of surgery for intrusion or extrusion.

	Amount of bite opening (intrusion) possible		Amount of bite closing (extrusion) possible	
	Min	**Mand**	**Min**	**Mand**
Only orthodontic treatment	2 mm	4 mm	4 mm	2 mm
Orthodontic tooth movement combined growth modification	5 mm	6 mm	6 mm	5 mm
Orthognathic surgery	15 mm	10 mm	10 mm	15 mm

Transverse plane

Midline discrepancies: One of the most important diagnostic features in orthodontic treatment planning is maxillary midline position. Maxillary midline position is done relative to facial midline, any deviation of this midline is considered abnormal. Often the patients which are undergoing orthodontic treatment presents with the midline deviation so in orthodontic diagnosis the extent of deviation is measured from the soft tissue midline, presumably because an objective will be for the two midlines and the mandibular midline to be coincident after the treatment [12,13].

The facial landmarks such as the nose, philtrum and chin are often used as references for maxillary midline positioning, may not themselves be centered on the face or with each other. Because the location of these midline landmarks are not generally altered as a result of orthodontic treatment, it would be useful to know their relative importance for determining optimum esthetic goals for positioning of the dental midline. According to Arnett and Beggman the philtrum is usually a reliable midline structure and can be used as the basis for midline assessment [14,15].

Diagnosis of midline discrepancies

In each patient an appropriate database for detection of midline asymmetries should be assembled to aid in making an appropriate diagnosis of the nature; extent; and location of the midline asymmetry. A detailed facial and intra-oral examination should be done; intra- and extra-oral photographs or video; dental models trimmed to centric relation occlusion; an occlusogram; a lateral cephalogram; a posteroanterior cephalogram; panoramic radiograph; and a submentovertex radiograph should be used for a thorough diagnosis. This thorough examination will aid in the visualization of the facial and the dental midlines; as well as their inter-relationship [7].

There are six important midlines that must be determined [16-18]:

- Facial midline
- Skeletal midline
- Maxillary apical base midlines
- Mandibular apical base midlines
- Maxillary dental midlines
- Mandibular dental midlines

DETERMINATION OF TREATMENT PLANNING

The first thing to be done in planning the treatment and mechanics is selection of a treatment midline. The final goal is represented by this midline. The treatment midline may coincide with either the upper or lower dental midlines or in sudden instances both upper and lower midlines may have to be moved to make them coincident with the facial midline [17].

In cases where both upper and lower dental midlines are coincident but the upper and lower soft tissue/skeletal midlines are not then the treatment midline should be assessed along with surgical alternatives [17].

Often apical base discrepancies are associated with asymmetric left and right molar occlusion so the apical base midline asymmetries require careful attention during the treatment planning process. If the apical base discrepancy is up to 2.0 mm; it is advisable to select either the upper or lower midline; whichever is closest to the facial midline as a treatment midline for larger apical base discrepancies; both upper and lower midlines may need correction [18].

Apical base midline discrepancy may be present with or without tipping of the incisors if both apical base midline discrepancy and tipped incisors are involved; the treatment mechanics should make adjustments for the treatment of two separate problems [18,19].

CONCLUSION

- Possibility of each type of treatment is not symmetric with respect to plane of space. For example tooth movement by orthodontic means alone is more possible antero-posteriorly than vertical direction.
- Growth modification is more effective in mandibular deficiency (10 mm) than mandibular excess (5 mm).

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