Case Report

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Inclination of Occlusal Plane and Its Impact on Smile Esthetic: A Case Report.

Abstract :
Improving facial esthetics is one of the primary goal of orthodontics and several factors have been proposed to achieve this goal.Instead of focus singonly on achieving perfect occlusion or ideal cephalometric values emphasis should be laid onto achieve frontal smile esthetics and study various factors that affect it.This case report determines the influence of the inclination of occlusal plane(IOP)on smile attractiveness and shows how by modifying the IOP we could achieving better facial esthetics or smile to be precise. Hence, this concept of IOP should be kept in mind while doing treatment planning and should be modified according to treatment needs.

Key words: Occlusal plane; Smile; Esthetics; inclination of occlusal plane; class II elastics; Components of smile; Dental esthetics ;class II subdivision; Smileanalysis; Smile arc.

Introduction :

Facial attractiveness has a great impact on social interaction and personality development and one of the main facial characteristics that more positively influences is the smile as rightly said by great author, Dale Carnegie, that one of the most important way to win friends and influence people is to smile. Webster defines the smile as "a change of facial expression involving a brightening of the eyes, an upward curving of the corners of the mouth with no sound and less muscular distortion of the features than in a laugh that may express amusement, pleasure, tender affection, approval, restrained mirth, irony, derision or any of various other emotions."[1,2]

Hence, improvement of facial esthetics, more specifically, enhancing smile has become one of the primary objective of orthodontic treatment in recent years. Traditionally, orthodontic treatment was focused mainly on achieving an ideal occlusion and improvement in the lateral soft tissue profile rather than frontal esthetics which is most often the major concern of the patient but in the last two decades there has been a shift in emphasis toward frontal esthetics or frontal smile to be precise .[3-6]

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Smile has been classified into different types by different authors, e.g. Ackerman et al. classified smile into two basic types: The social smile/posed smile and the enjoyment smile/unposedsmile. Posed smile is reproducible and voluntary whereas the enjoyment smile/unposed smile/Duchenne smile, is an involuntary smile and is elicited by laughter or great pleasure and results from maximal contraction of the elevator and depressor muscles causing full expansion of the lips, gingival show, and maximum anterior tooth display (Figure 1).[7,8]

Fig. 1: A, Posed smile is voluntary and may produce fairly reproducible lip animation; B, unposed smile is involuntary

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and spontaneous, often characterized by more lip elevation than in posed smile.

Tjan classified smile as low, average and high smile line, based on the amount of dental and gingival exposure during a natural full smile.[9] According to him, low smile line is one in which exposure of the maxillary incisors is less than 75% and no gingiva is seen, in average smile 75-100% of the maxillary anterior teeth are visible along with interproximal gingiva and high smile line is one in which 100% of anterior teeth can be seen along with contiguous band of gingiva.

Esthetic smile has been proposed to have eight major components according to Roy Sabri which include lip line, smile arc, upper lip curvature, lateral negative space (buccal corridor), smile symmetry, occlusal frontal plane, dental components and gingival components.[10]

Apart from the above-mentioned factors, one of the most important factor which is also often, the most neglected, is the effect of the inclination of occlusal plane (IOP) on smile esthetics. The IOP is a two-dimensional segmentation of a three- dimensional phenomenon; on cephalometric radiograph, a straight line is used to represent an imaginary plane at the level of occlusion. Occlusal plane has been determined differently by different authors ; the most commonly used is the bisected occlusal plane (BOP) proposed by Downs , the BOP is a line connecting the point bisecting the first molar cusp height and the point bisecting the incisal overbite, next we have functional occlusal plane (FOP) also known as posterior occlusal plane given by Rio et al which is a plane formed by bisecting the intercuspation of the first premolars and the intercuspation of the first molars. Another important occlusal plane that should be kept in mind is the esthetic occlusal plane which is formed by joining the disto-buccal cusp tip of maxillary molar to the point which is commonly 3mm below from where the relaxed upper lip meets the incisor. Lastly, we have the anterior occlusal plane (AOP) proposed by Fushima et al and Tanaka formed by a line that intersects the maxillary second premolar cusp tip and the maxillary central incisal which has a special significance in establishing smile esthetics as it is the most affected by a change in occlusal plane by orthodontic treatment.

Thus, when IOP is not within the normal range it may have a deleterious effect on smile esthetics . When the maxillary occlusal plane is canted upward anteriorly or rotated anti-clockwise , it will result in a non-consonant smile arc. On, the contrary if the occlusal plane is canted downward anteriorly or rotated clockwise , it will lead to a more consonant smile arc (Fig 2). Although, excessive canting of occlusal plane anteriorly will again lead to an un-esthetic smile as the lower lips will now cover the upper incisors. Hence, this concept of IOP should be kept in mind while doing treatment planning and should be modified according to treatment needs.[11]

The occlusal plane can be modified both during the growing phase and even after growth cessation. During the growing phase various extra oral appliances like cervical pull headgear can be used to utilize growth and achieve a desired occlusal plane. After the completion of growth ,orthognathic surgery is an option to change the occlusal cant by differential impaction of maxilla in which the maxilla can be rotated clockwise or anti-clockwise according to the treatment need. Apart from the above mentioned surgical procedures there are several non-invasive methods which can change the occlusal cant and achieve better smile esthetics starting from change in position of brackets according to our need e.g. in patients who have a non- consonant / flat smile arc ,maxillary central incisors brackets can be placed more gingivally. Secondly utility arches or archwires with accentuated curves which are commonly used for intrusion must be used judiciously as over-intrusion may lead to a flattened smile arc. Similarly , with the advent of temporary anchorage devices (TADS) the change in occlusal plane can be done easily by selective intrusion of anterior or posterior teeth. Lastly , we should not neglect the humble class II elastic as they are routinely used and are easily accepted by the patient when compared to the above mentioned methods and do have an effect on the occlusal plane .[12-14]

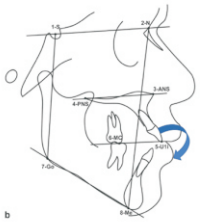


Fig2. Clockwise movement of occlusal plane shown by blue arrow

This article presents the importance of incorporation of the concept of IOP in treatment planning in order to achieve a better smile arc and how procedures and mechanics are modified to achieve them. In the present case it is illustrated how treatment planning and smile goal setting go hand in hand.

Case report:

A 19 Year old male patient presented to our department with the chief complaint of spacing and forward placement of his upper and lower front teeth.

Diagnosis:

Clinical examination revealed a convex profile, mild posterior divergence, competent lips, deep mentolabial sulcus. He had Class II molar and canine relation on right side and Class I molar and canine relation on left side. The lower midline was found to be shifted 2 mm towards right side with respect to the upper dental and facial midlines (Fig 3).

The oral hygiene status was average. Temporomandibular joint (TMJ) assessment revealed no history of pain or clicking on maximum opening and closure. The right and left excursive movements were normal. Maximum mouth opening was 39 mm.

Panaromic radiographic examination showed that all teeth were present and revealed optimum bone support for orthodontic mechanotherapy (Fig 3). TMJ space revealed normal size, shape and position of the condylar heads.

On cephalometric assessment the pre-treatment ANB angle was found to be 4° and MPA was 20° pointing to a Class II skeletal base and a hypo-divergent growth pattern (Table 1). As clinical examination already revealed proclined upper and lower incisors hence the 1/NA, 1/NB and IMPA angulations were also found to be increased i.e. 33°, 38° and 126° respectively.

Treatment Plan and Progress:-

Treatment goals were to correct the patient's skeletal and dental relationships and improve the soft-tissue and facial esthetics. Two treatment options were discussed. First ,was to extract 14, 24, 34 and 45 followed by finishing the case in ideal Class I molar and canine relation with midline correction. Secondly, 14, 24 and 34 extraction and finishing the case in Class II subdivision molar relationship and Class I canine relationship bilaterally. In the present case the second option was selected as it is easy and more successful in correcting midline along with closure of extraction space .

Patient was referred for extraction of 14, 24 and 34 before commencing levelling and aligning.Full fixed Preadjusted Edgewise appliance MBT of 0.022" (3M UnitekTM Gemini Metal Brackets) prescription was placed and banding and bonding was done along with Trans Palatal Arch (TPA). Upper second molars were also banded. Levelling aligning was commenced on 0.012" NiTi (3M Unitek Nitinol Super elastic wire) and gradually reached a thicker gauge wire of 0.017" X 0.025" SS in the upper and lower arches in a period of six months.

After levelling and aligning ,0.019" X 0.025" stainless steel arch wire was placed to be used for retraction. Class II elastics (3.5 oz and size - 5/16") were used specifically as it served dual purpose ,firstly for space closure and midline correction and secondly to create a clockwise rotation of the occlusal plane creating a more consonant smile arc in the process.Spee was given in upper archwire to maintain torque during retraction (Fig4).

After 15 months of active treatment, class II subdivision molar relationship, ideal overjet and overbite with pleasing soft tissue profile with an esthetically pleasing consonant smile arc was achieved (Fig5). Following this, debonding was done and post treatment records were taken. Fixed bonded lingual retainer given in upper and lower arch for retention.

Results:-

The post treatment facial photographs showed marked improvement in smile and facial profile. Maxillary anterior teeth protrusion was corrected, and a Class II molar relationship on right side and Class I molar relation on left side was maintained with Class I canine relationship achieved bilaterally. The overjet and overbite were corrected and were now within normal range. The upper incisors to NA plane had decreased from 33° to 25° and the lower incisors to NB plane decreased from 38° to 25° (Table 1). The retraction of the maxillary incisors contributed to correction of the soft tissue profile (Fig 5). A notable change was seen in the AOP and BOP which changed from 7°and 2° to 10°and 4°respectively (Table 1) leading to more consonant smile arc (Fig 6).

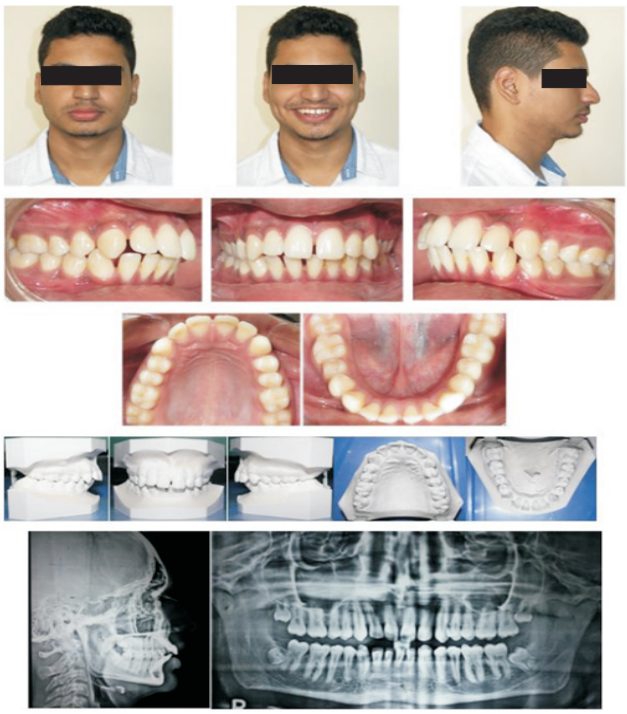
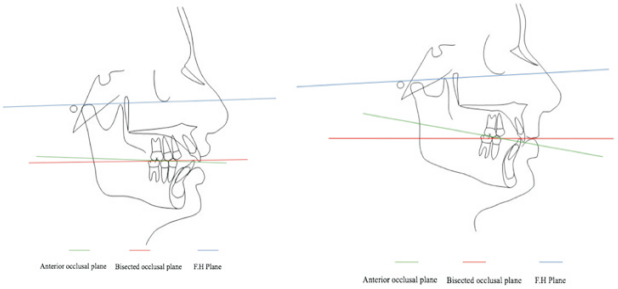


Fig. 3 Pre-treatment records

Fig. 4After 6 months of treatment 0.019" X 0.025" stainless steel arch wire used for retraction and Class II elastics (3.5 oz and size - 5/16") were used for space closure and midline correction and secondly to create a clockwise rotation(blue arrows) of the occlusal plane creating a more consonant smile arc in the process

Fig. 5 Post treatment records



A B

Fig. 6 (A) pretreatment AOP and BOP in respect to FH plane (B) post treatment AOP and BOP in respect to FH plane. An increase in AOP and BOP in post treatment can be appreciated

TABLE 1: Cephalometric Readings of The Patient's Lateral Cephalograms Tracing.

	CEPHALOMETRIC DATA		
	NORM	PRE TREATMENT	POST TREATMENT
SNA	82°	85°	84°
SNB	80°	81°	81 °
ANB	2°	4°	3°
MPA	32°	20°	21 °
1/NA	22°	33°	25°
1-NA	4.0mm	8 mm	3 mm
1/NB	25°	38 °	25°
1-NB	4.0mm	7 mm	3 mm
IMPA	90°	126 °	103°
1/1	131°	93°	135°
AOP	10° +/- 3.85°	7°	10°
BOP(Downs)	1.5° - 14°	2°	4°

Discussion :

The role of facial appearance on a person's social acceptance and interaction has been suggested by several authors. It has been said that one's facial attractiveness has great impact on his or her personality, confidence, performance, employment prospects and even kinship opportunities. This correlation between facial appearance and social acceptance was proved by a meta-analysis done by Langlois et al which concluded that people who are more attractive are viewed and treated more positively than unattractive people , even by those who know them. An attractive smile is an integral part of facial esthetics as during social interaction our mouth or our smile to be more precise is the centre of communication and facial expression. This correlation between facial appearance and smile was demonstrated in a study done by Eli et al and Newton et al where photographs of subjects were shown to a panel and was concluded that subjects with esthetic smiles

were attributed of having higher intellectual and social abilities as compared to un-esthetic smiles and even same individuals in which photographs were modified to have less esthetic smile.[15-20]

As already established that smile is an integral part of facial esthetics, so it's not a surprise that one of the main reason that a person seeks orthodontic treatment is to improve his smile. Historically, it was thought that the key to achieve an esthetic smile was to attain an optimal occlusion and a lot of research was done to develop guidelines and methods to achieve this with the help of cephalograms and patient's profile photographs. With the advancement in technology and increased patient awareness about esthetics there has been a gradual shift toward an increased emphasis on dental esthetics in treatment planning and now an esthetically pleasing smile is a key desired outcome of orthodontic treatment.Thus , identifying the factors of an esthetically pleasing smile has become one of the main goal for orthodontists and researchers worldwide and several authors came up with their factors to improve smile.

Roy Sabri came up with eight components for esthetic smilewhich included lip line, smile arc , upper lip curvature, lateral negative space(buccal corridor), smile symmetry, occlusal frontal plane, dental components and gingival components. [10]

Andre Wilson Machado gave 10 commandments for an esthetic smile namely smile arc ,ratio and symmetry of maxillary central incisors , proportion between antero-superior teeth , presence of antero-superior spaces , gingival design , gingival exposure , buccal corridor ,midline and tooth angulation and Lip volume.[21]

In addition to the above-mentioned factors, one of the most important factor which is also often, the most neglected, is the effect of the inclination of occlusal plane (IOP) on smile esthetics.

The importance of IOP has been advocated by several authors time and again raging from plastic surgery, prosthodontics to orthodontics and general dentistry.

Sylvie Lamarque advocated that IOP should be included as an integral part of treatment planning and specific measures should be taken in order control the IOP. He advocated the use of different treatment mechanics and force systems for patients with normodivergent, hyperdivergent, and hypodivergent skeletal patterns.[22]

Tanaka EM, Sato S devised a study to see how the IOP and position of mandible are related in order to establish a functional determinant which would help in the prediction of growh patterns in different dentoskeletal frames. For this he took 406 lateral cephalograms of 102 orthodontically untreated patients. The results concluded that IOP has a major role in the development of different dentoskeletal frames and was found to be steeper in class II patients and flatter in classIII patients. [23]

Okuda studied the importance of IOP on mandibular position and dental arch form with the help of cephalometrics and functional EMG studies of masseter, anterior and posterior temporalis muscles and concluded that IOP is a major factor for the harmony of the morphology and function of the stomatognathic system.

In a study done by Ogawa et al it was seen how IOP affected the patterns of closing and the concerning musculature and was found that closure patterns became more anteriorly convex when IOP was more in anterior direction and conversely posterior convex closure patterns were seen when IOP was inclined more posteriorly.[24]

Apart from the above mentioned effects of IOP , one more important aspect on which IOP has a profound effect is smile esthetics. When the IOP is canted upward anteriorly or rotated anti-clockwise , it will result in a non-consonant smile arc and when it is canted downward anteriorly or rotated clockwise , it will lead to a more consonant smile arc (Fig 2). Although , excessive canting of occlusal plane anteriorly will again lead to an un-esthetic smile as the lower lips will now cover the upper incisors. So , the concept of IOP should be kept in mind while doing treatment planning and should be modified according to treatment needs as studies indicate that fixed appliance therapy causes a change in IOP and ultimately change the curvature smile arc (Hulsey, 1970; Lindaueret al., 2005).[25]

In the present case Class II elastics (3.5 oz and size - 5/16") were used specifically as it served dual purpose firstly for space closure and midline correction and secondly to create a clockwise rotation of the occlusal plane creating a more consonant smile arc in the process. The results revealed a change in AOP and BOP as compared to pre-treatmentvalues

and a clockwise rotation of occlusal plane resulting in an increase in the curvature of smile , thus creating a more consonant smile arc in the process.

Mah et al (2013)devised a study to see the effect of change in the IOP on the curvature of smile arc for which forty six class II div I patients treated by all four first premolar extraction cases were selected. The changes in FOP and AOP were measured cephalometrically and were correlated to the changes in the curvature of smile arc. The results indicated clockwise rotation of the AOP and a corresponding increase in the curvature of smile arc and was thus concluded that the change in smile arc of the subjects was correlated to amount of change in the inclination between the pre-treatment and post treatment AOP and FOP . This relationship between IOP and smile arc was also found in studies done by Lombardi et al and Ackerman et al.[11]

A B

Fig 7. Improvement in smile arc after orthodontic treatment with fixed mechanotherapy changing from (A) non consonant smile arc to (B) an esthetically pleasing consonant smile arc

In the present case there was an improvement in the smile arc by increasing the curvature of smile (Fig 7) but many studies report that there is a flattening of the smile after orthodontic treatment (Hulsey, 1970; Lindaueret al., 2005) which may be due to difference in characteristics between the study sample, hence direct comparisons between these studies is impossible .[25,26]

Zimmer B et al designed a study to see the effects of intermaxillary elastics on the inclination of occlusal plane for which 32 skeletally homogeneous patients were divided into two groups with one group given class II elastics and other group in which class III elastics was applied. The results concluded that class II elastics had a clockwise and class III elastics had a counter clockwise shift in the occlusal plane. This goes in accordance to the present case where application of class II elastics created a clockwise rotation of occlusal plane.[27]

Batwa et al devised a study to see the effect of IOP on smile attractiveness for which he placed model of upper arch and mounted it on an articular and noted the variations in vertical tooth positions at different occlusal plane angles .Now this data was used to do photographic manipulations for smile prediction at differing occlusal plane angles (0, 5, 10, 15, and 20 degrees) which were then assessed by participants. The results concluded that change in IOP does have an effect on smile esthetics. However, patients were more tolerant of these changes than dentists which deemed a slight change in smile arc as unattractive.[28]

Conclusion:

Facial esthetics is the main reason people visit an orthodontist. So, we as orthodontics should keep the patients expectations at top priority and try to improve their smile esthetics rather than focussing on only achieving perfect occlusion or ideal cephalometric values. In the present case we have seen how IOP can have an important effect on smile esthetics. Hence, this concept of IOP should be kept in mind while doing treatment planning and should be modified according to treatment needs.

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