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CHANGES IN OCCLUSAL PLANE INCLINATION FOLLOWING ORTHOGNATHIC MANDIBULAR SETBACK SURGERY

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ABSTRACT:
***Objective:** This study aimed to evaluate maxillary and mandibular skeletal changes, and OP inclination changes in combined surgical-orthodontically treated patients skeletal class III patients by Bilateral sagittal split osteotomy setback. Further analyze the variations of OP inclination related to functionality, esthetics, and subset-based dentition analysis, and analyze the correlation between skeletal and Occlusal plane parameters.*
***Methods:** A research for the pre besides post treatment cephalograms in patients with a mean age of 23± 2.7 years who met the requirements for inclusion was conducted. The skeletal and occlusal plane parameters were mapped and calculated using the programme of Ilexis, (Sweden) FACAD AB-2017 Version 3.9.0. To compare the variables between occlusal parameters and skeletal pre in addition post treatment the opposite t-test was used. The Correlations between skeletal parameters and occlusal plane variables were determined with the bivariate correlation coefficient.*
***Results:** The results show a very high statistically significant increase in the FOP and BOP. However, based on the inclination changes of OP related to subset dentitions, the maxillary dentition shows no significant changes. The inclination of OP related to mandibular subset dentition shows significant changes. The correlation analysis reveals a skeletal parameter of the inclination of the mandible relates to the changes in the inclination of OP.*
***Conclusion:** The surgical-orthodontic approach involving BSSO setback resulted in a significant change concerning the occlusal lane inclination.*

***Keywords** - Bilateral sagittal split osteotomy, Mandibular setback, Occlusal plane, Orthognathic surgery.*

INTRODUCTION

The importance of understanding the Occlusal plane (OP) is indispensable in orthodontics [1]. In some dental and aesthetic regions, such as prosthodontics, orthognathic, maxillofacial, aesthetic, cosmetic, and reconstructive surgery, the OP also plays a major position [2,3]. The OP exhibits an individual character in its form and inclination which has a modulating effect on the functionality of the stomatognathic system and aesthetics of dentofacial appearance.

The inclination of OP is a major determining factor in the occlusion, thereby contributing to the functional masticatory movements of the jaw [4]. The alterations that profoundly influence the smile arc are the inclination of OP which forms an integral component of dentofacialaesthetics. The alterations in the inclination and cant of OP has shown to influence the attractiveness of smile [5,6].

The prevalence of continual changes in craniofacial growth and development reflects in occlusal relationships. These adjustments in occlusal relationships primarily contribute to variations in morphology and function of the occlusal plane. The main contributors to the variations in the OP are growth, head and neck muscles, rotation of the mandible during growth, tooth eruption, and nutritional habits [7-9]. These alterations in the inclination of OP exhibits particular phenotypic variations related to the dentoskeletal framework of the individual [10]. A particular predisposition which affects the predisposition of the occlusal even growth variations in the skeletal paatern and malocclusion type is predicted. The inclination changes in OP are a reflection of differential maxillary, mandibular skeletal growth, and condylar adaptive response [9]. The previous studies have analysed these variations in inclination changes of OP based on functionality and aesthetics in skeletal Class II subjects [11,12]. A particular study has also evaluated the inclination changes of OP in subjects treated orthodontically [13]. Also, these changes are evaluated in subjects treated by first premolar extractions [14]. However, there exists a large void in the literature concerning the changes in the inclination of OP and its relation to its functional, aesthetic, and subset dentition-based analysis when concerned with the surgical-orthodontic combined approach. Such an orthognathic approach recreates entirely new biomechanically neutral positions, which address not only the aesthetic parameter but also creates an entirely new functional standpoint. With these objectives of understanding, the goals of this study are

- Cephalometrically evaluate maxillary and mandibular skeletal changes, and Occlusal Plane inclination changes when treated using orthognathic procedure.
- Analyze the variations of OP inclination related to functionality, aesthetics, and subset based dentition analysis
- Analyze the correlation between skeletal and Occlusal plane parameters
- The null hypothesis states that there are no variations in inclination of occlusal plane parameters post-treatment involving mandibular setback.

MATERIALS & METHODS

This retrospective analysis was done in using pre- and post-treatment cephalograms of orthognathic patients treated by BSSO mandibular setback treated at our institution. Initially, the study contained reports of 35 Class III skeletal patients that had been examined. Two records attributable to insufficient pre-operative records, two records where genioplasty was done, and three records consisting of handled cleft lip and palate along with the orthognathic treatment were discarded from a total of 7 case records. The final study consisted of 28 patients who met the inclusion criteria, with a mean age of 23± 2.7 years.

***Inclusion Criteria*:**

Patient documents that meet the requirements for inclusion were chosen.:

- Dento-alveolar Class III skeletal Class III component-related molar relation.
- Completed presurgical orthodontics using fixed appliance treatment.
- Orthognathic interference by the setback of bilateral sagittal split osteotomy (BSSO).
- Lateral cephalogram before procedure and after operation between 4-12 months.
- Indian descent patients.

***Criteria for Exclusion*:**

- Post-surgical orthodontic surgery has not done for those patients.
- Genioplasty and Rhinoplasty like Surgical adjunctive operations has not been undergone by the patients.
- Bi- jaw correction was subjected to patients.
- Patients with this form of forked lip or appreciation.
- Patients that have inherited syndromic diseases.
- Past of earlier orthodontic or prosthodontic drug therapy.

To minimise magnification errors, patients' lateral cephalogramz is standardised. Using PLANMECA, all lateral cephalograms were taken (PROMAX). The width of the film was set at 5 feet for the X-ray tube and the usual head position (NHP) 15 was taken. At 60–72 kV, 1–16 mAS, the films were exposed, and a 2.5 mm aluminium philtre or similar was used.
Presurgicalin addition post-treatment cephalograms have been mapped after calibration by means ofIlexis, (Sweden) FACAD AB- 2017 Edition 3.9.0 programme [16].

PARAMETERS & MEASUREMENTS

Cephalometric studies involving the different parameters of the occlusal plane as tabulated (TABLE.1) and clustered are co-related with pre and post cephalogram skeletal parameters (TABLE 2,3). In this analysis, as the reference axis, the sella-nasion (SN) line is used to assess the inclination shifts in the occlusal planes comparative to the emaciated surround. The same investigator mapped and weighed the cephalograms. Randomly selected lateral cephalograms of 5 patients were selected and examined again in order to monitor the error of calculation. The duplicate determination and error in measurements were defined by Dahlberg, following the formula [17]. In addition, the reliability coefficient was also measured as 98.83 percent and 99.48 percent, according to Houston, 1983, suggesting a high degree of reliability [18].

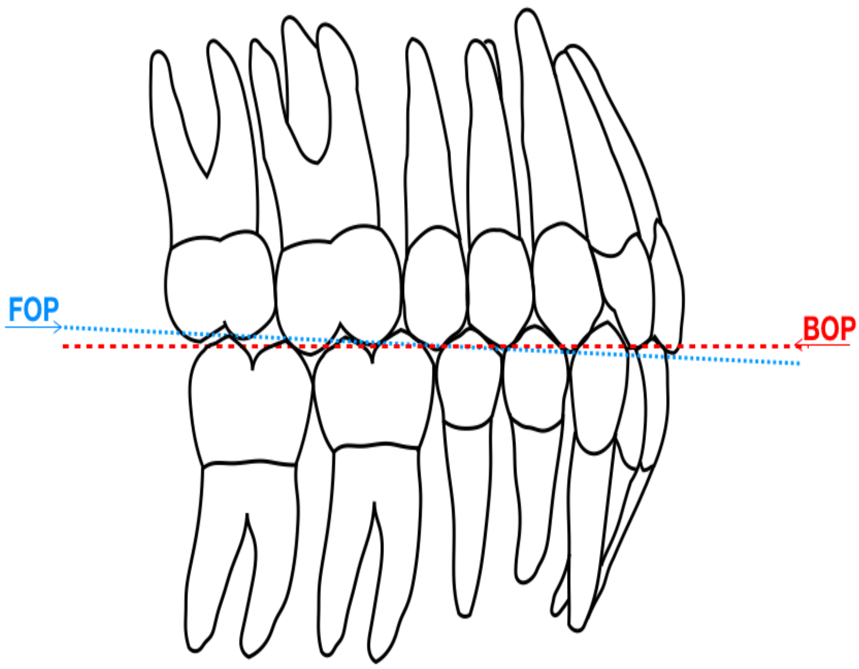

Figure 1. Functional and aesthetic component of occlusal plane evaluated in this study
FOP - Functional occlusal plane; BOP - Bisected occlusal plane

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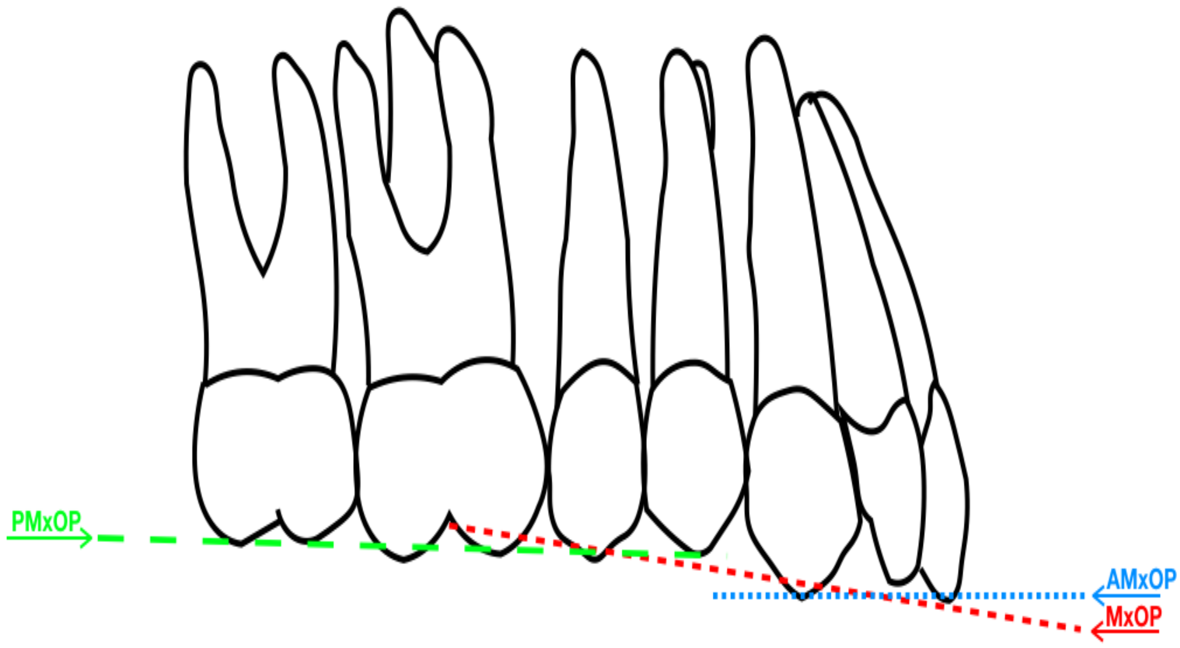

Figure 2. Maxillary occlusal planes evaluated in this study
MxOP - Maxillary occlusal plane; AMxOP - Anterior maxillary occlusal plane; PMxOP - Posterior maxillary occlusal plane.

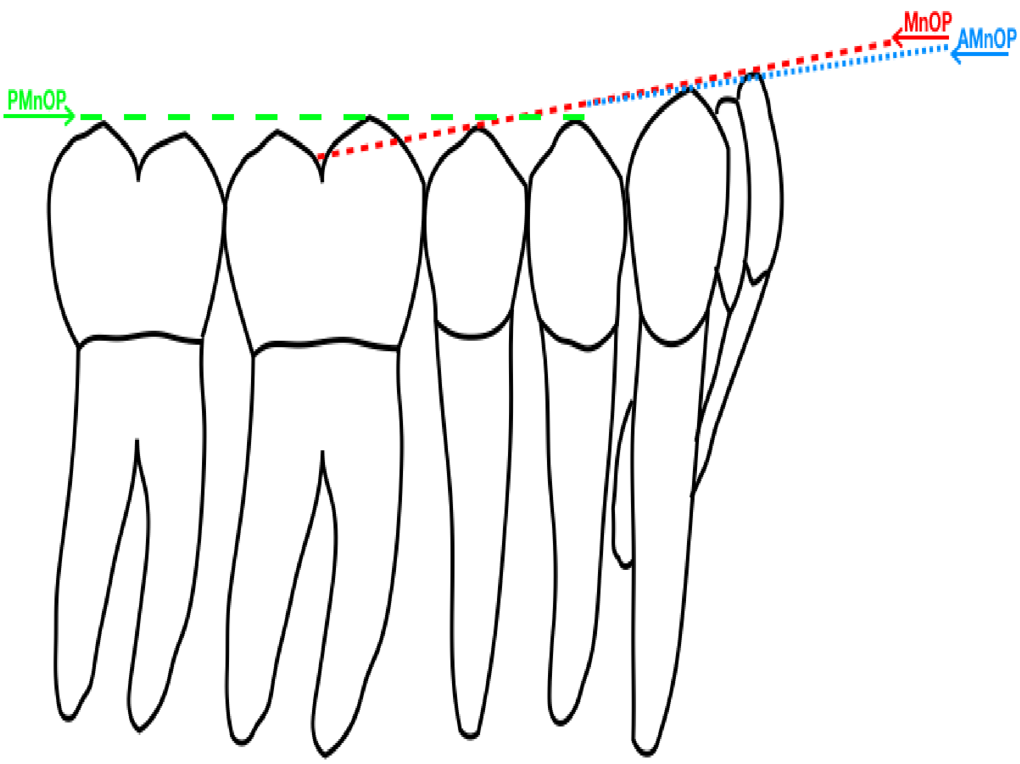

Figure 3. Mandibular occlusal planes evaluated in this study
MnOP - Mandibular occlusal plane; AMnOP - Anterior mandibular occlusal plane; PMnOP - Posterior mandibular occlusal plane

Table 1. Description of occlusal parameters used in this study [13,14,20]

Occlusal Parameters	Description
FOP	A line joining the point bisecting the U6 occlusal and L6 occlusal with the midpoint bisecting the intercuspation of the first premolars
BOP	The line that bisects the vertical distance between the upper and lower incisal tips (U1 tip, L1 tip) and the upper and lower first molar occlusal surface (U6 occlusal, L6 occlusal
MxOP	A line drawn from the incisal edge of U1 to the midpoint of the U6 on the occlusal surface
AMxOP	A line drawn from the incisal edge of U1 to the cusp tip of U3
PMxOP	A line drawn from the cusp tip of U4 to the cusp tip of U7
MnOP	A line drawn from the incisal edge of L1 to the midpoint of the L6 on the occlusal surface
AMnOP	A line drawn from the incisal edge of L1 to the cusp tip of L3
PMnOP	A line drawn from the cusp tip of L4 to the cusp tip of L7

Table 2. Skeletal Measurements used for this study

Parameters	Description
SNA	Angle determined by points S, N, and A
SNB	Angle determined by points S, N, and B
ANB	Angle determined by points A, N, and B
NF-NSL	Angle formed between Nasal floor and the Anterior cranial base
MP-NSL	Angle formed between Mandibular plane and the Anterior cranial base

Table 3. Occlusal Measurements used for this study

Parameters	Description
FOP-NSL	Angle formed between Functional Occlusal plane and the Anterior cranial base
BOP-NSL	Angle formed between Bisected Occlusal plane and the Anterior cranial base
MxOP-NSL	Angle formed between Maxillary Occlusal plane and the Anterior cranial base
AMxOP-NSL	Angle formed between Anterior Maxillary Occlusal plane and the Anterior cranial base
PMxOP-NSL	Angle formed between Posterior Maxillary Occlusal plane and the Anterior cranial base
MnOP-NSL	Angle formed between Mandibular Occlusal plane and the Anterior cranial base
AMnOP-NSL	Angle formed between Anterior Mandibular Occlusal plane and the Anterior cranial base
PMnOP-NSL	Angle formed between Posterior Mandibular Occlusal plane and the Anterior cranial base

STATISTICAL ANALYSES

On the paired samples and t-test a power analysis was conducted for statistically relevant improvements in skeletal and occlusal plane parameters using G-power Version 3.1.0.95 was the outcome of the power review. In order to compare and co-relate the variations between pre- and post-treatment skeletal and occlusal parameters, using IBM SPSS version 19.0 (IBM Crop.) the data obtained was analysed with paired-sample t-test. With the bivariate correlation coefficient, the associations between particular skeletal parameters and occlusal plane variables were calculated. The degree of statistically important was set at $p < 0.05$.

Table 4. Pre-to post-treatment changes in Occlusal plane and skeletal parameters of skeletal class III patients treated by BSSO setback were evaluated using paired t-test (SE: Standard error, Sig.: Level of significance *p<0.05, **p<0.01, ***p<0.001)

Parameters	Pre-Treatment		Post-Treatment	Differences		P Value [A]	
	MEAN	SD	MEAN	SD	MEAN	SD	
SNA	81.18	3.01	81.18	3.01	ND	ND	NS
SNB	84.15	2.15	80.33	2.67	3.82	1.28	***
ANB	1.24	2.63	0.81	0.69	-2.05	2.74	*
NF-NSL	6.30	0.97	6.31	0.99	-0.01	0.03	NS

Parameters	Pre-Treatment		Post-Treatment		Differences		P Value [A]
	MEAN	SD	MEAN	SD	MEAN	SD	
MP-NSL	27.70	4.54	30.47	3.38	-2.77	2.62	**
FOP-NSL	13.03	1.09	15.02	1.79	-1.98	0.99	***
BOP-NSL	12.74	1.57	14.20	1.80	-1.45	0.74	***
MxOP-NSL	9.90	1.32	9.92	1.33	-0.02	0.04	NS
AMxOP-NSL	9.38	1.07	9.36	1.01	0.02	0.10	NS
PMxOP-NSL	9.43	0.99	9.45	1.05	-0.02	0.08	NS
MnOP-NSL	15.43	0.94	17.67	2.32	-2.24	1.66	**
AMnOP-NSL	13.84	2.35	15.67	3.76	-1.82	1.66	**
PMnOP-NSL	12.97	1.63	15.66	3.76	-0.97	1.27	*

RESULTS

A contrast of presurgical (T1) besides post-treatment (T2) cephalometric values of the skeletal besides occlusal plane of 28 class III samples treated with single-jaw mandibular reversal surgery and their individual p values is provided in Table.4. The skeletal parameters relating the mandibular skeletal anteroposterior parameter to the cranial base (SNB) and maxilla (ANB) has shown a statistically significant reduction at T2 by 3.820 and 2.050 respectively when compared to T1. However, with this reduction in SNB and ANB, in the mandibular plane (MP-NSL) at T2 by 2.770 there is a statistically significant increase. Whereas, the values such as SNA and NF-NSL remains with no difference and statistically insignificant changes seen at T2 when compared to T1.

The inclination changes amongst occlusal plane variables at pre-treatment (T1) and post-treatment (T2) showed a very high increase in statistically meaningful terms in the inclination of practical occlusal plane(FOP) and bisected occlusal plane (BOP) by 1.980 and 1.450 with a p-value < 0.001 respectively at T2. There is also a statistically important rise in the orientation of the mandible-related occlusal plane, such as the mandibular occlusal plane (MnOP), the anterior mandibular occlusal plane (AMnOP) and the posterior mandibular occlusal plane (PMnOP) at T2, respectively, by 2,240, 1,820 and 0,970.The occlusal plane variables relating to the maxilla such as the Maxillary occlusal plane (MxOP), Anterior maxillary occlusal plane (AMxOP), and Posterior Maxillary occlusal plane (PMxOP) shows no statistically significant changes at T2.

The Bivariate correlation analyses conducted between various skeletal and occlusal parameters are tabulated in Table.5. From these results there prevails a direct correlation between the inclination changes occurring in the mandibular plane (MP-NSL) to the inclination changes of occlusal plane parameters such as FOP, BOP, and all the three variables relating to the mandible (MnOP, AMnOP, PMnOP). Of these occlusal plane parameters FOP, BOP and MnOP show the highest statistical significance with an R-value of 0.790, 0.806, and 0.817. The PMnOP and AMnOP show a lesser statistically significant correlation of R-value of 0.729 and 0.745 as compared with the previously stated occlusal plane parameters. The other skeletal parameters show no direct statistical significant correlation to the occlusal plane inclinations.

Table 5. Bivariate Correlative analysis of post-operative skeletal parameters and occlusal parameters

		FOP	BOP	MnOP	AMnOP	PMnOP
SNB	*r Value*	-.014	.100	-.216	-.024	-.177
	P Value	971	.798	.577	.951	.649
ANB	*r Value*	.421	.401	.271	.233	.264
	P Value	259	.285	.480	.546	.493
MP-NSL	*r Value*	.790	.806	.817	.745	.729
	P Value	0.011	0.009	0.007	0.021	0.026

DISCUSSION

In this study, we attempted to analyze in-depth inclination changes occurring in different occlusal planes, which reflects the functionality(FOP), the esthetics (BOP), and alterations occurring individually with the maxillary dentition (MxOP, AMxOP, and PMxOP) and the mandibular dentition (MnOP, AMnOP, and PMnOP). The research was a pre-post retrospective nature study reviewed with paired t-test findings from 56 lateral cephalograms of 28 patients through skeletal class III malocclusion treated with the surgical-orthognathic form of BSSO mandibular setback. In this study, the sella-nasion (SN) line-dependent calculation of the occlusal plane angle is used as the reference plane to determine the variations in the direction of the occlusal plane relative to the cranial base. Since the SN line size tends to be reasonably constant during general growth [19].Additionally, the sella and nasion in lateral cephalogram have reasonable reliability in addition repeatability. The post-surgical skeletal modifications have been examined and a correlation is presented with the inclinations of the occlusal plane.

The mean age of the cohort was 23±2.7 years in the present analysis, and because this age is well beyond development and skeletal maturity, more growth problems and maturation changes are dismissed [20]. The occlusal plane adapts to the basic variations occurring in the vertebral, dental, and chronological age as the person grows since these patients are past their growth no further alterations in their biological rhythms are expected [7,21].

From the results of this study the skeletal variables SNB, ANB, and MP-NSL assessed shows a statistically significant variation relating to the mandible. The mean post-treatment reduction in the SNB by 3.820 is in agreement with the previous study by Johnston et al. in 2005 which stated a mean reduction in the SNB of about 15% [22]. The mean changes in the ANB value in this study are around +2.050 which is more than the previously reported studies but effectively co-related with the reduction in the SNB [22,23]. This analysis benefits from an improvement in the angle of the mandibular plane that is in positive alignment with the previous studies [23-25]. This research does not however, mention any major improvements observed in the maxilla, so the SNA remains stable following therapy.

This study which analyses the occlusal plane inclinations in the surgical-orthognathic approach by far to our knowledge is the first of its kind. The previous reports in the literature relating to the changes in the occlusal plane are centered on the orthodontic treatment alone [13,14]. Also, more significant studies on skeletal class II and division 1 subjects were performed to evaluate the occlusal plane inclinations [11]. This lack of previous evidence relating to the changes occurring in this occlusal plane owing to the class III skeletal malocclusion and surgical-orthognathic corrections was satisfied by this study. This study is also the first of its kind in analyzing the occlusal plane to such depth by studying the functional component (FOP), esthetic component(BOP), and six individual components of the maxillary and the mandibular dentition.

The results of the current study showed very high statistically significant results owing to the increase in the inclination of the FOP and BOP post-treatment. Also, the occlusal plane relating to the mandibular dentition (MnOP, AMnOP, and PMnOP) has shown an increased inclination with statistically significant changes post-treatment. The association study shows a strong correlation between mandibular plane inclination and an improvement in FOP, BOP, and occlusal plane inclination in comparison to mandibular dentition.. However, the more anticipated changes in the maxillary posterior occlusal plane and other occlusal planes relating to the maxillary dentition showed no statistically significant changes. The previous reports which hypothesized aimaginable relationship between the disposition of the maxillary posterior occlusal plane in addition the mandibular location was not found in concordance with this study [13]. This study also differs from a study by Li et al. in 2013 where the reports of that study found no inclination changes in FOP in orthodonticallypickled patients alone whereas this study on combined surgical-orthodontic approach has found a significant difference [13].

The findings of this research refute the null hypothesis, while stating that there is an enhanced change in the tendency of post-treatment occlusal plane parameters concerning mandibular set-back alone. This rise in occlusal plane inclination rises is directly related to the changes in the inclination of one skeletal parameter, the mandibular plane. Therefore, during a hybrid surgical-orthognathic strategy involving mandibular setback alone the findings of the current study provide a predictive basis for the possible improvements in the tendency of OP.

The drawbacks of this current retrospective study are the absence of any subclass classification of class III skeletal features. Since this study involves a smaller sample size of 28 class III subjects, further subclassification based on their skeletal features was not possible. Also, the cephalometric data provided in this study does not include the summations of follow up data. Furthermore, future studies should include the assessment features involving other types of orthognathic approaches involving the maxilla and bi-jaw with subclassification grouping and follow-up data as the alteration in the muscular atmosphere is cited in the orientation of the practical occlusal plane as a source of recurrence.

CONCLUSION

We thus point out visible improvements in the alignment of the occlusal plane seen post-treatment in patients undergoing skeletal class III correction involving the BSSO setback protocol from this cephalometric review. The components of the functional, aesthetic, and

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mandibular sub-set occlusal planes relate to the alteration in inclination changes of the occlusal plane. This research also indicates a clear statistical association between the changes in inclination in the mandible impacting the shift in inclination in the post-BSSO occlusal plane setback surgical-orthodontic approach.

REFERENCES

[1]. Lamarque S. The importance of occlusal plane control during orthodontic mechanotherapy.Am J OrthodDentofacialOrthop 1995; 107:548–58.
[2]. Jayachandran S, Ramachandran CR, Varghese R. Occlusal plane orientation: a statistical and clinical analysis in different clinical situations. Int J Prosthodont 2008; 17(7): 572–575.
[3]. Kim BC, Lee CE, Park W et al. Integration accuracy of digital dental models and 3-dimensional computerized tomography images by sequential point and surface based markerless registration. Oral Surg Oral Med Oral Pathol Oral RadiolEndod 2010; 110(3): 370–378.
[4]. Ogawa T, Koyano K, Suetsugu T. Characteristics of masticatory movement in relation to inclination of occlusal plane. J Oral Rehab 1997; 24:652–57.
[5]. Batwa W, Hunt NP, Petrie A, Gill D. Effect of occlusal plane on smile attractiveness. Angle Orthod 2011; 82:218–23.
[6]. Olivares A, Vicente A, Jacobo C, Molina SM, Rodríguez A, Bravo LA. Canting of the occlusal plane: perceptions of dental professionals and laypersons.Med Oral Patol Oral Cir Bucal. 2013 May 1;18(3):516-20.
[7]. 7.Simoes WA. Occlusal plane: a clinical evaluation. J ClinPediatr Dent. 1995; 19(2):75-81.
[8]. Mercier J, Gordeeff A, Delaire J. Changes in the posterior vertical dimension of the face. Etiopathogenic factors, architectural criteria and therapeutic aspects. Orthod Fr. 1989;60 2:575-82.
[9]. Carek V, Jerolimov V, BukovićD Jr, Baucić I, Radionov D. Radiographic cephalometry of the facial profile. CollAntropol. 1997 Dec;21(2):549-54.
[10]. Tanaka EM, Sato S. Longitudinal alteration of the occlusal plane and development of different dentoskeletal frames during growth. Am J OrthodDentofacialOrthop 2008; 134(5):602.1-11.
[11]. Fushima K, Kitamura Y, Mita H, Sato S, Suzuki Y, Kim YH. Significance of the cant of the posterior occlusal plane in Class II division 1 malocclusions.Eur J Orthod. 1996; 18:27–40.
[12]. Thayer TA. Effects of functional versus bisected occlusal planes on the Wits appraisal. Am J OrthodDentofacialOrthop 1990;97(5):422-6.
[13]. Li JL, Kau C, Wang M. Changes of occlusal plane inclination after orthodontic treatment in different dentoskeletal frames. ProgOrthod 2014; 15:41.
[14]. Zenab Y, Hambali TS, Salim J,Endah M. Changes of occlusal plane inclination after orthodontic treatment with four premolars extraction in dento-alveolar bimaxillary protrusion cases. Padjadjaran J Dent 2009.
[15]. Moorrees CF. Natural head position--a revival. Am J OrthodDentofacialOrthop1994;105(5):512-3.
[16]. Naoumova J, Lindman R. A comparison of manual traced images and corresponding scanned radiographs digitally traced. Eur J Orthod 2005; 31:247–253
[17]. Dahlberg A. Statistical Methods for Medical and Biological Students.Public Health 1940; *54:* 92-93.
[18]. Houston WJ. The analysis of errors in orthodontic measurements. Am J Orthod1983;83(5):382-90.

ISSN 2515-8260 Volume 07, Issue 09, 2020

[19]. Chang HP, Kinoshita Z, Kawamoto T. A study of the growth changes in facial configuration. Eur J Orthod 1993; 15:493–501.
[20]. Vukusic N, Lapter M, Muretic Z. Change in the inclination of the occlusal plane during craniofacial growth and development. Collegium Antropol 2000; 24:145–50.
[21]. Proffit WR, Fields HW:Contemporary Orthodontics 2ed. pp 134-36, 1993.
[22]. Johnston C, Burden D, Kennedy D, Harradine N, Stevensond M. Class III surgical-orthodontic treatment: A cephalometric study. Am J OrthodDentofacialOrthop 2006; 130:300-9.
[23]. Aaronson SA, Monica S. A cephalometric investigation of the surgical correction of mandibular prognathism. Angle Orthod1967;37(4):251-60
[24]. Posnick JC, Fantuzzo JJ, Orchin JD. Deliberate operative rotation of the maxillo-mandibular complex to alter the A-point to B-point relationship for enhanced facial esthetics. J Oral MaxillofacSurg 2006; 64(11):1687-95.
[25]. Harada K, Kikuchi T, Morishima S, Sato M, Ohkura K, Omura K. Changes in bite force and dentoskeletal morphology in prognathic patients after orthognathic surgery. Oral Surg Oral Med Oral Pathol Oral RadiolEndod 2003; 95(6):649-54.