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Correlation of Pre-treatment Factors to Selected Treatment Modalities in Class III Deformity "Orthodontic versus Combined Orthodontic and Orthognathic Surgery"

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ABSTRACT

Class III is a complex dentofacial deformity and requires an accurate treatment planning to achieve the best possible aesthetic and functional outcome by keeping the complications rate low. We looked for pre-treatment parameters correlated to the selected treatment modality.

Material and methods: Lateral cephalometric radiographs of 74 adults with Class III deformity were analyzed. One group received orthodontic treatment and the other combined orthodontic and surgery. A logistic regression model analysis was performed to identify independent predictive skeletal, facial and aesthetic parameters that were significantly influenced by the chosen treatment modality.

Results: Moderate statistical significance was observed in nose prominence (p=0.040), lower lip length (p=0.017), SNB (p=0.014), SNA (p=0.020) and ANB (p=0.026). The distance of the upper lip to the aesthetic line (p=0.003), the cervical length (p=0.009) and the ratio (p=0.007) were statistically significant to the performed treatment modality.

Conclusion: We observed 7 cephalometric parameters with significant relationship to the selected treatment modality. However, we do not know if the orthodontist or the surgeon considered these factors for their planning. Further investigation is needed to illuminate this issue and the impact of each factor on outcomes.

INTRODUCTION

The etiology of Class III malocclusion is rather heterogeneous involving complex interactions between various genetic, epigenetic, environmental and iatrogenic factors. These factors can act individually or simultaneously [1-5]. It is a complex type of dentofacial deformity that requires a thorough and accurate treatment planning to achieve the best aesthetic and functional outcome.

The clinical manifestation of Class III malocclusion ranges from mild malocclusion involving only the dentoalveolar component. It may also present complex skeletal discrepancies of craniofacial region. These include maxillary retrognathism, mandibular prognathism, excessive or insufficient growth of the maxilla, and combined or isolated deficiency. Additionally, deviations in transversal and vertical plane can also be present. They usually suffer from facial disharmony that can impact their psychological wellbeing [1,2,5].

Several treatment modalities have been utilized to correct skeletal Class III anomalies. These include growth modification with orthopaedic appliances, conventional orthodontics and camouflage up to combined orthodontic and orthognathic surgery [1-3,5-7]. Despite the recent advancement in diagnostic modalities and treatment options, defining a clear algorithm to select one or other treatment modality is still missing. The arbitrary guiding parameters are anthropometric values based on cephalometric details. The decision process is also influenced by anatomical limitation, long-term stability of achieved result, rate of complications of the procedure, and comorbidities of the patient [1-4,7-10].

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The aim of this study was to identify pre-treatment skeletal, facial and aesthetic parameters that correlated significantly to selected treatment modality. These pre-treatment parameters could be used to facilitate the decision process in treatment planning.

MATERIALS AND METHODS

This study was carried out in accordance with the ethical standards of the 1964 Declaration of Helsinki. Prior to beginning the Study, it has been reviewed and approved by the ethics committee (EK 150/13) in our University. The Names of Patients were anonymous and the consent process was not compulsory.

The data originated from the Department of Orthodontics of the XXXXX University from January 2013 to December 2016 and includes all patients with the following criteria:

1- Class III molar relationship

2- Negative overjet

3- ANB <0°; Wits <–1 mm

We excluded patients with craniofacial syndromes, cleft lip and palate, and facial trauma in the medical history. Seventy-four consecutive patients were selected and divided into surgical (n=39) and non-surgical (n=35) group. The non-surgical group received only orthodontic therapy and the surgical group had orthodontic treatment followed by bi-maxillary surgery with only 2 surgeons. The lateral cephalometric radiographs obtained before the treatment were evaluated. Seventy-four cephalometric landmarks on the craniofacial complex were identified and digitized. Dental image processing software (OnyxCeph3, v. 3.1.95; Image Instruments, Chemnitz, Germany) was used to analyze the cephalograms.

Statistical Analysis

All evaluations were performed by the same person and were repeated after 4 weeks to assess the measurement precision using the Dahlberg formula (standard error = $\sqrt{\Sigma d^2/2n}$) [11]. This formula showed the error of the method, reflecting the variability between any two independently measured values and the quantitative measurement error **(Table 1)**. The skeletal and soft-tissue values were evaluated with the SAS statistics program for Windows, Version 9.2. The logistic regression was used to identify the variables used in the diagnosis of surgical or non-surgical treatment of patients with Class III anomaly. The level of significance was set to 0.05. The logistic procedure was used to identify the variables that best separated the patients with a need for orthognathic surgery from those who did not. We performed a backward stepwise variable selection and aimed to obtain a model with the smallest set of significant parameters to avoid redundancy among the variables. The independent variables were included in the model according to the 5% level of significance. Descriptive statistics, including means, standard deviations, and Student t-test, were computed for each measurement **(Table 2)**.

Table 1. Measured values and the quantitative measurement error.

Variables	Before Surgery	After Surgery	Accidental Error
	Mean (SD)	Mean (SD)	
SNA (°)	78(4.9)	83(4.6)	0.8
SNB (°)	81(4. 49)	80.5(3.45)	0.79
Wits appraisal (mm)	-9.5(4 .23)	-3.0(2.86)	0.75
Gonion angle (°)	127.5(8.69)	128(8.19)	0.69
Maxilla inclination (°)	34.61(6.8)	34.76(6.44)	0.78
Upper 1 inclination (°)	105.61(7.61)	104.88(5.80)	0.81
Lower lip to E-line (mm)	-8.3(3.3)	-5.7(3.7)	0.51
Nasolabial angle	-2.5 (3.3)	-3.4(3)	0.78
Soft tissue facial angle	110(12.5)	100.6(12.2)	0.8
Upper lip thickness (mm)	18.2(3.5)	16.5(3.3)	0.51
Pg' (mm)	13(3)	13(4)	0.7
Upper lip length (mm)	21.9(4.3)	23.7(4.4)	0.4
Lower lip length (mm)	46.5(7.5)	48.1(6.1)	0.6
Cervical length (mm)	50.6(10)	47.9(10)	0.72
Lip chin throat angle	50.6(10)	47.9(10)	0.77
Upper lip to E-line (mm)	-8.3(3.3)	-5.7(3.7)	0.74

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RESULTS

We selected 74 Class III patients (36 females, 38 males; age range 18-34, mean 23; SD 0.77). Thirty-nine patients had orthodontic treatment followed by orthognathic surgery, and 35 received only orthodontic treatment **(Table 2)**.

Table 2 presents the descriptive statistics for all variables of both groups for the univariate data analysis and the levels of significance. Significant differences were found for parameters representing the sagittal maxillo-mandibular relationship as indicated by the Wits appraisal (p=0.0001), ANB (p=0.0001), SNB (p=0.0001) and SNA (p=0.0001). The comparisons of patients treated by conventional orthodontic and patients treated by combined orthodontic/surgery showed statistically significant differences between the distance of the upper lip to the aesthetic line (p=0.0001), the lip chin throat angle (p=0.0003), the soft tissue balance (Gl´SN´Lst, p=0.009), and the inclination of maxilla and mandible (p=0.042) **(Figures 1 and 2)**.

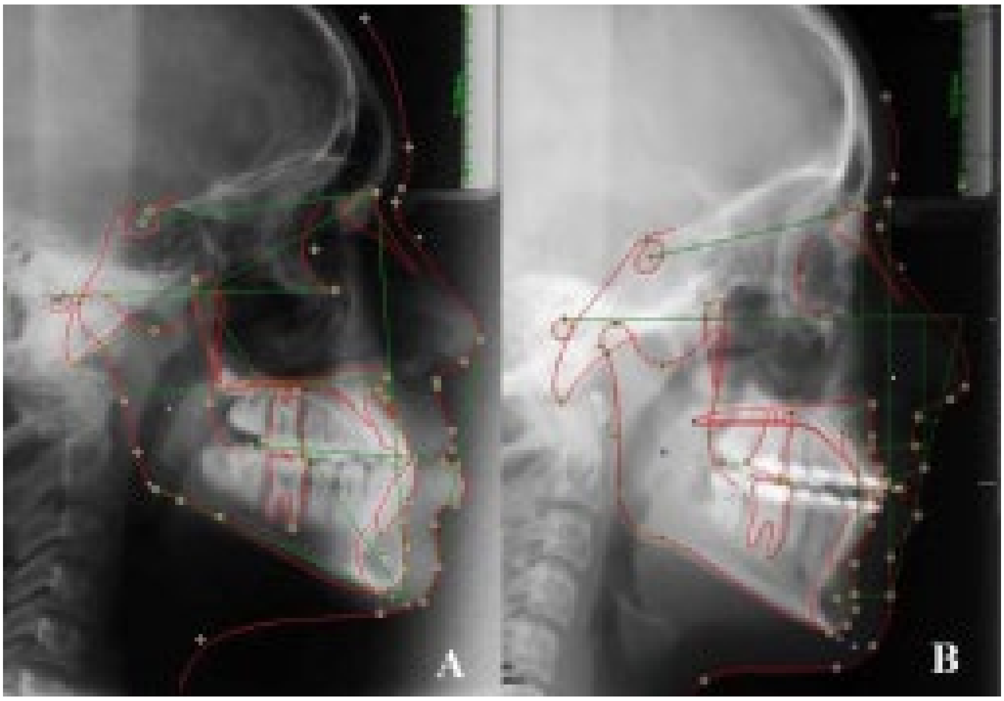

Figure 1. Lateral cephalometric radiographs of Non-surgery patient (a) pre-treatment (b) post-treatment.

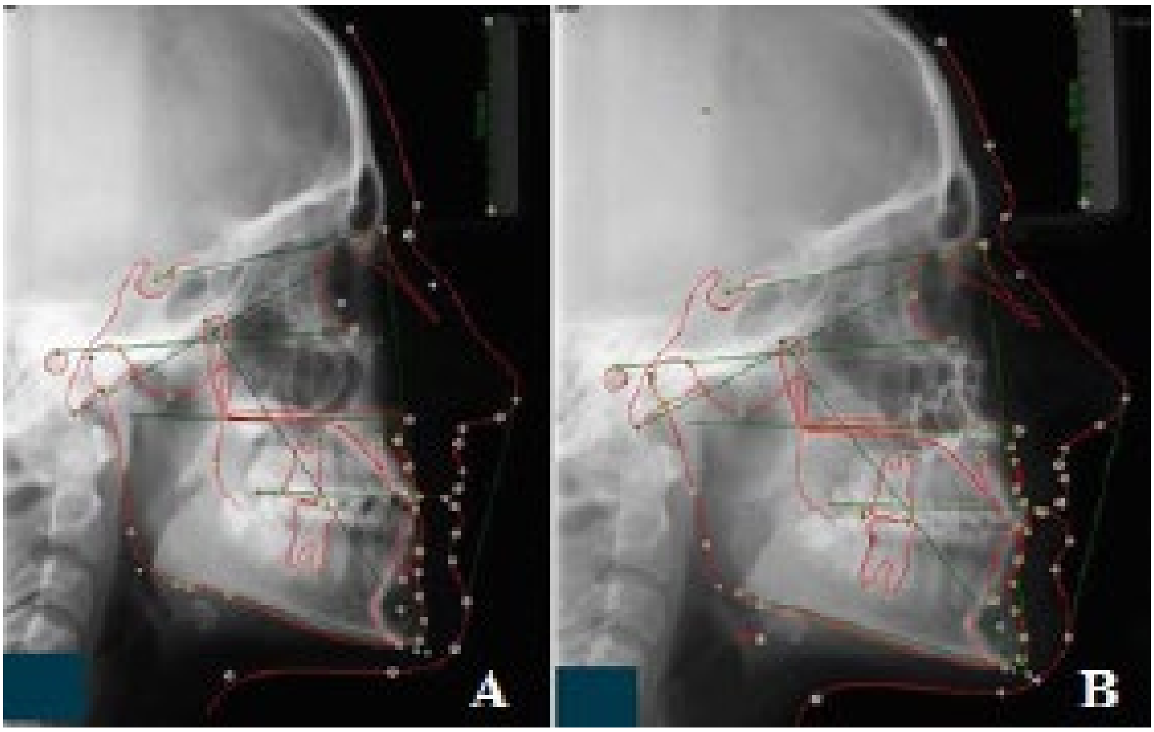

Figure 2. Lateral cephalometric radiographs of patient with surgery (a) Pre-treatment (b) Post-treatment.

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The logistic procedure and backward selection showed a significant difference for parameters of soft tissue including nose prominence (p=0.040), distance of the upper lip to the aesthetic line (p=0.003), lower lip length (p=0.017), cervical length (p=0.009) and for the skeletal parameter SNB (p=0.014), SNA (p=0.020), ANB (p=0.026) and ratio (p=0.007).

Table 2. Soft tissue cephalometric index in surgery/nonsurgery group (t-Test inhomogeneous variances, p<0.05*).

Variables	Surgery			Non-surgery		Surgery	Statistics(t) (df)	P-Value (exact)
	Mean T1	Mean T2	Mean Differences (SD)	Mean T1	Mean T2	Mean Differences (SD)		
SNA (°)	79	82.7	3.7 ± 3.6	78.9	78.4	-0.5 ± 2.7	5.53 (68.26)	<0.0001*
SNB (°)	82.9	80	-2.9 ± 2.7	79.4	79.4	-0.0 ± 2.4	-4.38 (70.91)	<0.0001*
ANB (°)	-3.8	2.5	6.3 ± 3.9	-0.5	-0.8	-0.3 ± 2.8	8.35 (68.34)	<0.0001*
Wits-Value (mm)	-11.4	-3.3	7.9 ± 5.6	-6.4	-5.7	0.7 ± 3.3	6.63 (62.43)	<0.0001*
Jarabak (%)	63.7	63.5	-0.2 ± 4.2	64.7	65	0.3 ± 1.9	-0.60 (53.76)	0.5494
ArGoMe (°)	131.5	129	-2.5 ± 5.1	128.9	127.6	-1.2 ± 3.4	-1.23 (66.95)	0.2213
ML-NSL (°)	36.6	36.3	-0.3 ± 4.0	35.0	35.1	0.1 ± 2.4	-0.58 (63.00)	0.5625
ML-NL (°)	29.2	27.8	-1.4 ± 5.0	29.0	29.5	0.5 ± 2.3	-2.06 (54.81)	0.0426*
U1 to Sn (°)	105.3	103.8	-1.5 ± 6.3	105.5	108.6	3.1 ± 6.4	-3.12 (71.03)	0.0026*
L1 to GoMe (°)	82.8	87.8	5.0 ± 5.9	88.5	89.4	0.9 ± 7.3	2.65 (65.51)	0.0100*
LL to E-Line (mm)	-2.2	-2.7	-0.5 ± 3.1	-2.8	-2.7	0.1 ± 2.4	-1.03(70.58)	0.3052
Nasolabial Angle (°)	109.2	100.7	-8.5 ± 10.3	104.2	104.5	0.3 ± 9.2	-3.88(72.00)	0.0002*
Soft Tissue Facial Angle (°)	93.8	93	-0.8 ± 4.1	91.0	91.5	0.5 ± 3.6	-1.50 (71.99)	0.1389
Nose Prominence (mm)	18	15.6	-2.4 ± 2.4	17.9	17.4	-0.5 ± 2.3	-3.59 (71.66)	0.0006*
UpL Thickness (mm)	16.6	16.5	0.1 ± 3.3	15.2	16.1	0.9 ± 2.9	-1.08 (71.94)	0.2847
Chin Thickness (mm)	12.8	13.3	0.5 ± 1.6	12.5	12.3	-0.2 ± 1.6	1.82 (71.17)	0.0737
UpL Length (mm)	22.3	23.4	1.1 ± 4.5	24	23.6	-0.4 ± 2.3	1.71 (57.78)	0.0915
LoL Length (mm)	48.7	46.8	-1.9 ± 4.9	45.3	45.1	-0.2 ± 3.9	-1.70 (70.97)	0.0932
Cervical Length (mm)	52	45.5	-6.5 ± 5.3	55.8	51.5	-4.3 ± 8.6	-1.34 (55.32)	0.1858
GISnLs (°)	-3.4	-7.6	-4.2 ± 7.0	-8.4	-9	-0.6 ± 3.7	-2.67 (58.90)	0,0093*
Lip Chin Throat Angle (°)	111.2	121.7	10.5 ± 9.0	109	111.2	2.2 ± 9.9	3.77 (69.81)	0.0003*
UL to E-Line (mm)	-8.9	-4.7	4.2 ± 2.6	-6.1	-6	0.1 ± 2.4	6.89 (71.91)	<0.0001*

DISCUSSION

Class III deformity is a skeletal anomaly with the influences of genetic that varies in prevalence among ethnic and racial groups [12-14]. The selection of the treatment is based on factors like the degree of sagittal and vertical skeletal discrepancy, the inclination and position of the incisors, and the facial appearance [3]. In their concept of the "3 envelopes of discrepancies", Profitt et al. [15] suggested the degree of maxillary incisor protrusion relative to mandibular incisor retrusion as a critical limitation when differentiating between orthodontic and combined orthodontic-surgical treatment. Kerr et al. [13] tried to establish cephalometric yardsticks to objectify the decision for treatment. The important factors that differentiated the surgery and orthodontic patients in their study were the size of the antero-posterior discrepancy, the inclination of the mandibular incisors, and the appearance of the soft-tissue profile. Also, Ghiz et al. [12] presented a logistic equation with four variables to predict the future success of early orthopedic treatment and could correctly classify 95.5% of the successfully treated infants but only 70% of the unsuccessfully treated infants. Stellzig-Eisenhauer et al. [16] reported that the stepwise variable selection in the DA generated a 4-variable model that produced an efficient distinction between the non-surgery and surgery groups. The variables chosen included the Wits appraisal, S-N, M/M ratio, and the lower Go angle. Schuster et al. [10] found three cephalometric variables for correct classification of pre-pubertal Class III malocclusion patients that could adequately be treated by orthopedic-orthodontic therapy only, and those who required additional orthognathic surgery. In the study of Kochel [3], the stepwise variable selection in the DA generated a new 4-variable model that produced the most efficient distinction between the non-surgery and surgery groups. In this study the variables of Wits appraisal, M/M ratio, saddle angle and MLD were chosen.

To assess errors in cephalometric digitizing, one investigator digitized the lateral cephalographs. The same investigator redigitized 25 randomly selected cephalographs after an interval of four weeks. The method errors between the double measurements were analyzed.

Additionally, we used the backward stepwise regression analysis that starts with all selected variables to test the impact of each variable. A chosen model of comparison criteria, deleting the least effective variable, was continued until no further improvement was possible. This study showed that parameters like SNA, SNB, ANB, M/M ratio (anterior-posterior facial relationships), nose prominence, and lower-lip-length could be decisive factors in selecting the treatment modality between a surgical and non-surgical treatment approach. Various studies [2,12] showed a positive aesthetic outcome of maxilla advancement in the sub mental and nasolabial region. The skeletal discrepancies between the maxilla and the mandible seem to be very important. However, the validity of using this parameter was the only indicator of sagittal jaw relationships was criticized [17,18].

There is no information whether the selected procedures were based on these parameters. The backward stepwise DA showed that SNB, ANB, SNA, M/M ratio, nose prominence, and lower-lip-lengths could be decisive diagnostic parameters to select the appropriate treatment modality for Class III orofacial deformity. All these parameters showed to be significant modified between non-surgical and surgical groups. The sagittal jaw relationships seem to be the most important factor to select the treatment modality compared to morphometric parameters of the mandible. Additionally, the nose prominence and lower lip lengths were significantly smaller in the surgical group than in the orthodontic group.

The relevance of the vertical dimension to select the treatment was therefore supported by the findings of this study. Patients in the non-surgery group showed significantly greater vertical values (P=0.0001) than those in the surgery group. Kochel et al. [3] suggested that for further improvement of the predictive value of the multivariate model, additional factors had to be considered like soft tissue features, incisal guidance, dento-facial aesthetics, and long-term stability. Adding the soft tissue variable can improve the predictive value in patients with Class III malocclusion with surgical needs.

This is a retrospective study based on pure statistical model. A source of bias of any retrospective study is the amount and type of population considered in the study, which may not be representative of the larger population group. These biases can occur also with the Class III patients considered for surgery or orthodontic treatment. Evidence exists those patients, who are particularly satisfied or dissatisfied with the outcome of their treatment, are more likely to respond to a request for follow-up than those with no emotional involvement. This bias can be a major problem for all studies that use long-term recall [19].

No significant differences appeared between the two sets of repeated measurements **(Table 2)**.

Hence, if a Class III malocclusion patient had at least four of the six conditions (overjet >–4.73 mm; Wits appraisal, >–11.18 mm; L1-MP angle, 80.8°; M/M ratio, >65.9%), then surgical treatment was performed.

In the surgery group, all patients had maxillary advancement and mandibular setback. The treatment decisions are influenced by several factors like the doctor-patient interaction, doctor expertise, attributing positive personal characteristics like caring, feeling that the doctor was concerned about the patient's well-being, and educating the patient [20-22].

The significant differences were found between both groups in terms of ANB angle, maxillary-mandibular (M/M) ratio, mandibular incisor inclination and Holdaway's angle. In view of the complex interaction of skeletal and dento-alveolar parameters, it seems highly improbable that single variables could contain sufficient information to explain the anomaly [23]. Furthermore, univariate statistical techniques were insufficient for diagnosis, treatment planning and outcome prognosis [24]. Therefore, recent studies recommended a multivariate approach for analyzing the relationship between craniofacial structure and Class III malocclusion [25-28].

CONCLUSION

We identified seven cephalometric measurements as the minimum number of discriminators that were important to selected treatments modalities in class III patients being on the borderline between surgical and non-surgical treatment approaches.

REFERENCES

1. Carlotti AE and George R. Differential diagnosis and treatment planning of the surgical orthodontic class III malocclusion. Am J Orthod. 1981;79:424-436.
2. Hamamci N, et al. Nonsurgical orthodontic treatment of an adolescent girl with Class III malocclusion and asymmetric maxillary narrowing. Am J Orthod Dentofacial Orthop. 2008;134:309-317.
3. Kochel J, et al. New model for surgical and nonsurgical therapy in adults with Class III malocclusion. Am J Orthod Dentofacial Orthop. 2011;139:e165-174.

4. Murakami C, et al. Craniofacial morphology of skeletal Class III patients before treatment and growth-related changes during treatment with a maxillary protraction appliance: a comparison of orthodontic and surgical cases. World J Orthod. 2005;6:51-60.

5. Tseng YC, et al. Treatment of adult Class III malocclusions with orthodontic therapy or orthognathic surgery: receiver operating characteristic analysis. Am J Orthod Dentofacial Orthop. 2011;139:485-493.

6. Burns NR, et al. Class III camouflage treatment: what are the limits? Am J Orthod Dentofacial Orthop. 2010;137:9.e1-9.e13.

7. Moon YM, et al. Cephalometric predictors of long-term stability in the early treatment of Class III malocclusion. Angle Orthod. 2005;75:747-753.

8. Fabre M, et al. Professionals' and laypersons' appreciation of various options for Class III surgical correction. Eur J Orthod. 2010;32:395-402.

9. Falter B, et al. Predicted versus executed surgical orthognathic treatment. J Craniomaxillofac Surg. 2013;41:547-551.

10. Schuster G, et al. Children with class III malocclusion: development of multivariate statistical models to predict future need for orthognathic surgery. Angle Orthod. 2003;73:136-145.

11. Dahlberg G. Statistical methods for medical and biological students. George Allen and Unwin Ltd., London. 1940;122-132.

12. Ghiz MA, et al. Cephalometric variables to predict future success of early orthopedic Class III treatment. Am J Orthodont Dentofac Orthopedics. 2005;127:301-306.

13. Kerr WJS, et al. Class III malocclusion: surgery or orthodontics? Br J Orthod. 1992;19:21-24.

14. Litton SF, et al. A genetic study of Class III malocclusion. Am J Orthod. 1970;58:565-577.

15. Profitt WR, et al. Prevalence of malocclusion and orthodontic treatment need in the United States: estimates from the NHANES III survey. Int J Adult Orthognath Surg. 1998;13:97-106.

16. Stellzig-Eisenhauer A, et al. Treatment decision in adult patients with Class III malocclusion: orthodontic therapy or orthognathic surgery? Am J Orthod Dentofacial Orthop. 2002;122:27-38.

17. Kahl B, et al. How to deal with the dropout in clinical follow-up studies: results of a long-term follow-up study of orthodontically treated patients. Am J Orthod. 1995;108:415-420.

18. Nurminen L, et al. Motivation for and satisfaction with orthodontic-surgical treatment: A retrospective study of 28 patients. Eur J Orthod. 1992;21:79-87.

19. Botelho RJ and Skinner H. Motivating change in health behavior. Implications for health promotion and disease prevention. Prim Care. 1995;22:565-589.

20. DiMatteo MR. A social-psychological analysis of physician-patient rapport: toward a science of the art of medicine. J Soc. 1979;35:12-33.

21. Johnston LE. A statistical evaluation of cephalometric prediction. Angle Orthod. 1968;38:284-304.

22. Keeling SD, et al. A multivariate approach to analyzing the relation between occlusion and craniofacial morphology. Am J Orthod Dentofacial Orthop. 1998;95:297-305.

23. Battagel JM. The identification of Class III malocclusions by discriminate analysis. Eur J Orthod. 1994;16:71-80.

24. Franchi L, et al. Predictive variables for the outcome of early functional treatment of Class III malocclusion. Am J Orthod Dentofacial Orthop. 1997;112:80-86.

25. Chang HP. Assessment of anteroposterior jaw relationship. Am J Orthod Dentofacial Orthop. 1987;92:117-122.

26. Ghassemi M, et al. Consideration of effect of the amount of mandibular setback on the submental region in the planning of orthodontic–orthognathic treatment. B J Oral and maxillofacial surgery. 2014;25:334-339.

27. Ishii H, et al. Treatment effect of combined maxillary protraction and chincap appliance in severe skeletal Class III cases. Am J Orthod Dentofacial Orthop. 1987;92:304-312.

28. Jacobson A. The “Wits” appraisal of jaw disharmony. Am J Orthod. 1975;67:125-138.