Associations between severity of dentofacial deformity and motivation for orthodontic-orthognathic surgery treatment

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A combined surgical and orthodontic approach in the correction of dentofacial deformities has become more prevalent in recent years. Patients with severe malocclusion due to skeletal discrepancies require diagnosis and treatment planning by both a surgeon and an orthodontist. Treatment plans should be devised so that the patient's expectations are fulfilled . The successful outcome of orthognathic surgery depends not only on optimal tooth movement and jaw repositioning but also on the concerns, motivations, and expectations of the patient.[1,2]

Numerous studies indicate that esthetics or improvement in facial appearance is an important motivating factor for patients who undergo orthognathic surgery. Others suggest that stomatognathic/functional improvements are an important consideration. It is commonly accepted that physical attractiveness has an effect on personality and social interactions. The aims of this investigation were: to analyze the association between the severity of the patient's dentofacial deviations from normative cephalometric values and motivation for orthodontic treatment and surgical correction, and to determine the association between esthetic concerns and motivation for orthognathic surgery by these same patients.

Laufer *et al.* [3] conducted a retrospective evalua-

Abstract

The successful outcome of orthognathic surgery is related to patient satisfaction and motivation. The aim of this retrospective study was to analyze the association between 1) severity of dentofacial deformity derived from cephalometric measures and 2) patient motivation for treatment. The initial cephalograms of 142 patients aged 16 years or older from the Dentofacial Program of the University of Michigan were traced and digitized. Inclusion criteria were established by assigning ANB 4° to 15° to define severe skeletal Class II (n=65) and ANB -15° to -4° to define severe skeletal Class III (n=20). Motivation for orthodontics and surgery was derived from clinician administered forms scaled 1-10 with Low (1-5) and High (8-10).

The cephalometric measure ANB was significant (p=0.02) for high/low motivation for orthodontic treatment using Student's t test. No other cephalometric measures were significant for high/low motivation for orthodontics or surgery using Student's t test. Class II patients were significantly (p=0.014) more motivated than Class III patients for orthodontic treatment. No significant difference was found for motivation for surgery between skeletal Class II and skeletal Class III patients.

Patients with severe sagittal Class II deformities had higher motivation for orthodontics than surgery. The cephalometric measure, ANB, defining severe skeletal Class II and Class III patients did predict motivation level for orthodontics. None of the other 18 cephalometric measures were predictive of patient motivation for either orthodontics or surgery.

Key Words

Orthodontics • Orthognathic surgery • Patient motivation • Cephalometrics • Skeletal ClassII/III

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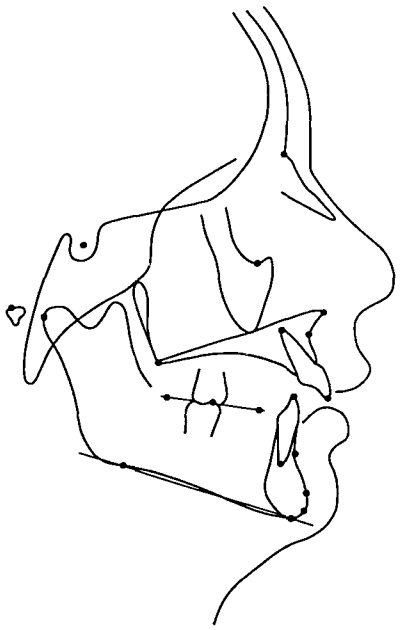

1 Sella Turcica
2 Nasion
3 Orbitale
4 Anterior Nasal Spine
5 A point
6 B point
7 Pogonion
8 Gnathion
9 Menton
10 Tangent posterior mandible
11 Condylion
12 Porion
13 Posterior Nasal Spine
14 Max. Central Incisor Apex
15 Incision Superius
16 Incision Inferius
17 Mand. Central Incisor Apex
18 Max. 1st Molar Mesial Cusp
19 Mand. 1st Molar Mesial Cusp
20-21 Functional Occlusal Plane

Maxilla:
SNA angle
Co-ANS mm
A pt- Na perp. mm
Mandible:
SNB angle
Co-Pg mm
SN- Mand. plane angle
Pg- Na perp. mm
Intermaxillary:
ANB angle
WITS mm
Harvold Unit diff.
Dentoalveolar:
Maxilla: Upper 1- SN angle
Mandible: IMPA angle
Vertical:
Facial: N-A pt. mm
ANS-Me mm
A pt.- Gn mm
Dental: Upper 1 - ANS mm
Lower 1-Me mm
Lower 6- Mand. pl. mm
Upper 6- Palatal pl. mm

Figure 1

Figure 1
A schematic representation of some of the digitized landmarks to define the 19 cephalometric measures. Definitions of the landmarks were obtained from the Riolo et al. atlas (1974).

tion of patients' attitudes and motivation following surgical correction for mandibular prognathism. They found the primary reason for seeking surgery was esthetics (56%) followed by difficulty in chewing (32%). Athanasiou *et al.*[4] also performed a retrospective study of 152 patients to determine the motivation for undergoing combined orthodontic-surgical treatment. They found the major concerns were surgical risk (36%), change of appearance (27.6%) and finances (15.8%). Additionally, Jacobson[5] conducted a post-treatment survey of 50 maxillofacial surgery patients. Most patients listed more than one reason for undergoing surgical treatment — the desire to improve facial appearance (76%), improve jaw function (70%), or encouraged by dentist or physician (58%).

A retrospective study of 90 orthognathic surgery patients was conducted by Flanary *et al.*[6] to investigate presurgical concerns and motivations. Three-fourths of the patients (76.7%) chose surgery because they wanted better function, and almost half (47.8%) desired an esthetic improvement. More females gave facial appearance as an important reason for surgery, but there was no significant gender difference in desire for functional improvement as a reason for surgery. Of those who listed facial esthetics as an important incentive for surgery, 81.4% reported improved function after the surgery. Of the patients who were initially hesitant to have orthognathic surgery (50%), the primary motivation was functional improvement rather than appearance. Patients with esthetic motives had fewer problems adjusting to an appearance changes than those who had strong functional motives.

More recently, Mayo *et al.*[7] examined the attitude variables for treatment decisions among patients at the University of Michigan's Dentofacial Deformity Program. They found the most prevalent concerns were related to facial and dental esthetics. Interestingly, the patient's perception of the affect the dentofacial deformity had on his or her quality of life was associated with a significantly higher motivation for surgical treatment. These findings have been verified by Barber *et al.*[8] where 52% of the same population reported a chief complaint related to facial and dental esthetics, 17% reported functional problems, and 12% had temporomandibular concerns.

Bell *et al.*[9] analyzed 80 patients who had been evaluated by an oral surgeon, an orthodontist, and lay persons concerning facial profiles. One-half of the patients elected to undergo surgical correction of their jaw deformities while the other half decided against surgery. Results of the study showed that in spite of recommendations for surgical treatment by dental specialists as indicated by cephalometric measurements, self perceptions of profile are more important in the patient's decision to undergo surgery.

Kiyak and Zeitler[10] examined the self assessment of facial profile among 90 patients before and after surgery. Patients diagnosed with mandibular hypoplasia perceived themselves significantly more prognathic in the maxilla and retrognathic

in the mandible. These perceptions approached the normal range during posttreatment assessment. Patients treated for maxillary hypoplasia rated themselves in the prognathic mandibular range both before and after treatment. The researchers concluded that the perception of facial profile by the patient is not necessarily consistent with the diagnosis.

Psychological interviews before and 6 months after orthognathic surgery were conducted with 52 patients (Olson and Laskin[11]), and the major finding was that most patients were satisfied with the results of their orthognathic surgery in terms of fullfilling their original expectations. This applies to all patients regardless of whether their original motives were functional, esthetic, or both.

A longitudinal study on different aspects of personality as predictors of surgical outcome was conducted by Kiyak *et al.*[12] Three groups of patients were examined: surgery only, orthodontic treatment only, and no treatment. Although the subjects in all three groups were similar initially, those who decided to undergo surgery were significantly more dissatisfied with their facial features. A critical review performed by Jensen[13] examined the relationship between psychosocial factors and orthognathic surgery for facial esthetics, and the majority of the patient's reasons for undergoing surgery were psychosocial. Heldt *et al.*[14] also noted that a history of emotional abuse may influence the patient's attitude and expectations regarding corrective treatment.

Figure 2
Cephalometric measures versus high/low motivation for orthodontic treatment

	mean ± S.D. High ortho	Low ortho	p value
Maxilla:			
SNA angle	81 ± 5	80 ± 5	0.62
Co-ANS mm	95 ± 6	95 ± 6	0.84
A pt- Na perp. mm	3 ± .4	3 ± .4	0.99
Mandible:			
SNB angle	77 ± 5	81 ± 10	0.06
Co-Pg mm	120 ± 8	123 ± 9	0.33
SN- Mnd. plane angle	34 ± 8	31 ± 10	0.27
Pg- Na perp. mm	-10 ± 10	-1 ± 19	0.15
Intermaxillary:			
ANB angle	4 ± 5	-1 ± 8	0.02*
WITS mm	12 ± 13	4 ± 17	0.11
Harvold Unit diff.	25 ± 6	29 ± 10	0.24
Dentoalveolar:			
Maxilla: Upper 1- SN angle	104 ± 9	105 ± 13	0.82
Mandible: IMPA angle	84 ± 10	91 ± 12	0.09
Vertical:			
Facial: N-A pt. mm	63 ± 6	60 ± 6	0.12
ANS-Me mm	77 ± 8	75 ± 10	0.52
A pt.- Gn mm	65 ± 7	67 ± 11	0.61
Dental: Upper 1- ANS mm	33 ± 4	32 ± 5	0.51
Lower 1-Me mm	45 ± 3	45 ± 5	0.99
Lower 6- Mand. pl. mm	35 ± 3	34 ± 5	0.91
Upper 6- Palatal pl. mm	26 ± 4	26 ± 5	0.93

Materials and methods

Morphologic measures

The characterization of the University of Michigan's Dentofacial Deformity Program has been recently described by Barber *et al.*[8] This study was aimed at the characterization of patients aged 16 years or older with severe skeletodental deformities, who were seen in the University of Michigan's Dentofacial Deformitites Program and received orthodontic treatment in the graduate resident or faculty clinic at the University of Michigan (Chou and Vig[15]). The gender distribution was 39% male and 61% female reflecting a male-female ratio of 1:1.5. The racial distribution was 88% white, 8% African-Americans, and 4% other.

Lateral cephalometric radiographs of patients were traced and 146 landmarks were digitized to obtain 19 cephalometric measures (Figure 1). The landmarks digitized were defined by Riolo *et al.*[16] in *The Atlas of Craniofacial Growth*. Each cephalogram was traced on more than one occasion to insure consistency and reliablity. The morphologic characteristics were stratified by sagittal discrepancy into skeletal Class II malocclusion (ANB 4° to 15°) or skeletal Class III (ANB -15° to -4°) and tested for associations with the demographic data.

Demographic measures

A retrospective analysis of the patient questionnaires was conducted. These patients did not have craniofacial anomalies or dysmorphic syndromes, but may be regarded as being at the extremes of normal craniofacial morphologic variation. The patient interview questionnaire, administered by an oral surgery or orthodontic resident, included standard demographic data and attitude variables.[7] The motivational measures were on an analog scale (1-10) while patient concerns were divided into functional versus esthetics. A response of 8-10 on the analog scale translated to high motivation for surgery or orthodontic treatment. Low motivation for either surgery or orthodontics was indicated by a response

Figure 2
Mean values ± standard deviations for the 19 cephalometric measures and p values as determined by the Student's t test between high/low motivation for orthodontic treatment. Only ANB was significant, p=0.02. The mean value of ANB for the high orthodontic motivation was 4° compared to -1° for the low orthodontic motivation group reflecting more skeletal Class II patients.

Figure 3
Cephalometric measures versus high/low motivation for surgery

	mean ± S.D. High surgery	Low surgery	p value
Maxilla:			
SNA angle	80 ± 5	81 ± 5	0.47
Co-ANS mm	96 ± 6	95 ± 5	0.55
A pt- Na perp mm	3 ± .4	2.9 ± .4	0.48
Mandible:			
SNB angle	78 ± 5	79 ± 8	0.5
Co-Pg mm	121 ± 8	122 ± 8	0.46
SN- Mnd. plane angle	33 ± 8	33 ± 8	0.87
Pg- Na perp. mm	-7 ± 10	-4 ± 18	0.57
Intermaxillary:			
ANB angle	2 ± 6	2 ± 6	0.9
WITS mm	9 ± 15	12 ± 15	0.52
Harvold Unit diff.	25 ± 8	28 ± 8	0.45
Dentoalveolar:			
Maxilla: Upper 1- SN angle	103 ± 11	105 ± 12	0.56
Mandible: IMPA angle	87 ± 11	86 ± 10	0.75
Vertical:			
Facial: N-A pt. mm	63 ± 6	63 ± 5	0.88
ANS-Me mm	77 ± 9	75 ± 7	0.23
A pt.- Gn mm	66 ± 8	64 ± 6	0.36
Dental: Upper 1- ANS mm	33 ± 5	32 ± 4	0.29
Lower 1-Me mm	46 ± 4	45 ± 4	0.44
Lower 6- Mand. pl. mm	35 ± 4	35 ± 3	0.99
Upper 6- Palatal pl. mm	26 ± 4	25 ± 4	0.28

Figure 3
Mean values ± standard deviations for the 19 cephalometric measures and p values as determined by the Student's t test between high/low motivation for orthognathic surgery. No measures were found to be significant.

of 1-5. Tests for association analyzed motivation for surgical and orthodontic treatment against concerns in the categories of dental and facial esthetics and functional concerns.

Statistical tests

Mean values and standard deviations were calculated for the high/low motivation groups for orthodontic treatment and surgery. Student's t-test was used to test the 19 cephalometric measures and high/low motivation for orthodontic treatment and surgery. A Chi-squared statistical test was used between skeletal Class II and Class III individuals, as determined by the ANB measure, and the high/low motivation for orthodontics and surgery. All p values were reported, and p=0.05 was established as being significant.

Results

There were more Class II patients (n=65) than Class III patients (n=20) for this sample as defined by the ANB measure. The Student's t-test was significant for the ANB measure and high/low motivation for orthodontics (p=0.021). No other cephalometric measure was found to be significant for high/low motivation for orthodontics or surgery using the Student's t-test (Figures 2 and 3).

Using contingency analysis, Class II patients were found to be significantly (Chi-squared= 6.02; p=0.014) more motivated than Class III patients for orthodontic treatment, as shown in Figure 4. No significant difference was found for surgical motivation between Class II and Class III patients.

Discussion

These findings are congruent with the studies by Bell and colleagues[9] and Kiyak and Zeitler.[12] In spite of recommendations for orthognathic treatment by dental specialists as indicated by cephalometric measurements, self perceptions of profile are more important in the patient's decision to undergo orthognathic treatment. There appears to be an unequivocal consensus among the studies reviewed that psychological benefits and patient satisfaction occurred after combined orthodontic treatment and orthognathic surgery, regardless of the patient's initial esthetic or functional motives. The few individuals who were dissatisfied with the surgical outcome either did not clearly express their expectations to the clinicians or did not fully comprehend the risks, pain, and other factors associated with this kind of treatment. Most current studies indicate the importance of esthetics and patient's self perception of their appearance in the decision to undergo treatment,[5,9,10] however, several other studies[4,6,11] have emphasized functional improvements as the most important incentive. Other researchers also noted the insignificance of personality measures as predictors of treatment success.[6,12]

Patients in the present study were more motivated for orthodontic treatment than for orthognathic surgery but the underlying factors varied. Most patients would like the least invasive treatment that will address the chief complaint. The finding of only ANB as significant when tested against motivation for orthodontics was not surprising, but other cephalometric measures that represent intermaxillary discrepancy, such as the WITS measure or Harvold unit difference, would probably have been significant as well. The WITS measure not being statistically significant may be a reflection of the dental compensations that have occurred attempting to camouflage the skeletal discrepancy. For example, the occlusal plane may have an exaggerated Curve of Spee or the maxillary incisor position may affect A

point. Likewise, the Harvold measures not being statistically significant may be an indication of a positional problem of the maxilla and/or mandible, not just a size problem.

None of the other cephalometric measures were significantly correlated with either motivation for orthodontic treatment or motivation for surgery. However there was a tendency for other measures which are related to ANB, such as SNB, to be significant. The mean SNB value for the group with a high motivation for orthodontic treatment was 77° compared to 81° for the group with low motivation, reflecting the tendency for the skeletal Class II individuals to have a higher orthodontic motivation. Unfortunately, the large standard deviations obscure some of the other potentially significant cephalometric measures.

When the sample was divided into skeletal Class II and skeletal Class III using the ANB measure, again the only statistically significant result was the Class II patients and high/low motivation for orthodontic treatment. Possibly more cephalometric measures and high/low motivation for orthodontic treatment or surgery would have been detected as significant if the cutoffs for the skeletal ANB discrepancy had been more extreme. However, that would have reduced the sample size further especially in the Class III sample. Cephalometric normative values selected for this study may have little correlation to the patient's real or perceived chief complaint. This may be particularly true in the area of severe dentofacial deformities requiring an orthodontic/orthognathic surgery treatment plan.

Nevertheless, the importance of the severity of patient's morphologic deviations from ideal values must be emphasized especially when TPI (Treatment Priority Index) and government policies for estimates of need are based on severity. This has consequences in determining whether a patient qualifies for insurance coverage and/or government funding for treatment. The degree of deformity often reflects severe or handicapping malocclusions and also has a direct effect on treatment priority when establishing a problem list. Determining the relationship between the patient's motivation for treatment and the severity of his or her morphological features will increase the chance that the orthodontic treatment/orthognathic surgery will be perceived successful by the patient, orthodontist and surgeon.

Figure 4

Chi-Squared Statistic

Motivation	N Class II	N Class III
High Orthodontic	45*	10
Low Orthodontic	4	5
High Surgical	30	12
Low Surgical	15	7

Figure 4
Using a Chi-squared statistic, skeletal Class II patients (n= 45) were found to be significantly more motivated than skeletal Class III (n=10) patients for orthodontic treatment (p= 0.014). No signficant difference was found for motivation for surgery between skeletal Class II and Class III patients.

Conclusions

1. Patients with severe sagittal Class II deformities had higher motivation for orthodontics than Class III patients.
2. The cephalometric measure ANB, defining severe skeletal Class II and Class III patients, could be used to predict motivation level for orthodontics.
3. None of the other 18 cephalometric measures were predictive of patient motivation for either orthodontic treatment or orthognathic surgery.

Treatment of patients with dentofacial deformities should not be based upon cephalometric analysis alone. The patient's perception of his or her facial profile and need for treatment are not necessarily consistent with the clinician's diagnosis. Thus, the clinician must clearly address the patient's motivations for orthognathic treatment in addition to other demographic variables regardless of the severity of the deformity. Future studies with larger samples are needed to look at the associations between other demographic, attitudinal, and cephalometric variables. These finding will help establish quantifiable measures of patient and clinician preferences for treatment, thereby increasing the chances of a successful orthodontic and orthognathic treatment.

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