**Functional needs in orthognathic patients with different sagittal skeletal discrepancies**

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## Abstract

Objectives: This retrospective study aimed to evaluate the relationship between the Index of Orthognathic Functional Treatment Need (IOFTN) and sagittal skeletal discrepancy (ANB angle) among orthognathic patients.

Study Design: Records of 403 orthognathic patients (229 females/174 males, aged 16-50 years) were reviewed. Malocclusion type (incisor-based), sagittal skeletal relationship (ANB angle), and IOFTN scores were documented. Spearman correlation coefficient (r) and scatter plots were utilized to examine the relationship between functional need (IOFTN scores) and sagittal skeletal discrepancy (ANB angle). Regression analyses were conducted to determine the extent to which variations in IOFTN scores could be attributed to variations in ANB angles.

Results: Class III malocclusion/sagittal skeletal pattern were most prevalent (62.3%). The Spearman correlation coefficient (r) for the entire sample was -0.297 ($P<0.001$), indicating a weak negative correlation. Linear regression analysis demonstrated a coefficient of determination of 0.069, indicating that approximately 6.9% of the variance in IOFTN data could be accounted for by variations in ANB angles. Upon stratifying data by different malocclusions, coefficients of determination were 0.065, 0.034, and 0.089 for Class I, II, and Class III malocclusions, respectively.

Conclusion: The observed linear relationships between sagittal skeletal discrepancy (ANB angle) and IOFTN score were weak and lacked clinical significance.



**Keywords:** IOFTN, ANB angle, sagittal skeletal discrepancy, Dentofacial Deformity, malocclusion, Orthognathic Surgery

**Funding:** none received

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## Clinical relevance

- The linear associations between the sagittal skeletal discrepancy (ANB angle) and the functional need (IOFTN) were weak
- Approximately 6.9% of the variance in IOFTN data could be accounted for by variations in ANB angles indicating a weak relationship

## Introduction

Orthognathic surgery is used often in combination with orthodontics for the treatment of dentofacial deformity. The documented benefits of orthognathic treatment encompass improvements in oral function, social adaptability, self-confidence, and improvement in body and facial image (1-3). Recent study examined the patient-perceived functional and psychosocial outcomes of orthognathic treatment (3). This included assessments of patient-reported function, body satisfaction, psychological wellbeing, and anxiety and depression before and after orthognathic treatment (3). Findings revealed improvements in reported functional problems, and in Body Satisfaction Scale, General Health Questionnaire, and in Anxiety questionnaire scores (3) and this was irrespective of the patient's age at the start of treatment (3).

Patients with dentofacial deformities exhibit significant deviations from the normal proportions of the maxillo-mandibular complex (4). Dentofacial deformities form 3 main categories (5). Some are congenital and present at birth such as facial clefts, craniofacial microsomia, dysmorphic syndromes, Pierre Robin sequence, and chromosomal anomalies. Some become evident with growth and development, and finally some are due to traumatic injury or pathologies such as cyst, tumour, juvenile idiopathic arthritis or condylar hyperplasia (5).

According to Reyneke and Ferretti (6) the four prime goals of orthognathic surgery are as follows,

1-Functions, this is often the main motivation for patients and aimed at achieving or addressing normal masticatory function, speech issues, sleep apnea, attrition of teeth, periodontal problems and TMJ issues
2-Stability of results, some osteotomies are inherently unstable such as widening or downward movement of maxilla, and setback of mandible (7,8)
3-Aesthetics, will be determined jointly by assessing patient concerns
4-Aairway, achieving the patency of upper airways, the support for retropharyngeal soft tissue is dependent on anterior osseous attachments, e.g., in Class III correction instead of mandibular setback movement that increases the risk of sleep apnea in future, a bimaxillary osteotomy with greater maxillary advancement and lesser mandibular set back is preferable.

Orthognathic surgery is predominantly performed as an elective procedure, and apart from medical conditions such as obstructive sleep apnea and some craniofacial anomalies, the clinical diagnoses of dentofacial deformity is not life-threatening (9-11). Therefore, establishing and substantiating the term "medical necessity" for orthognathic surgery can be challenging (10) and understanding patients' presenting concerns, motivations, and expectations is absolutely necessary (10,11). There is no international consensus on the criteria that should be used to identify patients who would benefit from orthognathic surgery; however, orthognathic surgery may be indicated and considered medically appropriate if the occlusal features or cephalometric values represent two or more standard deviation from published norms (5). The Index of Orthognathic Functional Treatment Need (IOFTN) (12), serves the purpose of identifying patients with the most significant requirements for orthognathic surgery. IOFTN was specifically designed to evaluate functional needs such as, biting and chewing, and it has been used in the UK and other countries (13). IOFTN primarily focuses on the functional aspects of malocclusion and incorporates a scoring system to assess factors such as excessive upper labial segment exposure at rest, complete scissor bites, sleep apnea, and facial asymmetries (12).

As mentioned earlier, in counties such as the USA, orthognathic surgery may be indicated and considered medically appropriate if the occlusal features or cephalometric values represent two or more standard deviation from published norms (5). For instance, the cephalometric ANB angle measures the sagittal skeletal discrepancy and can be used for this purpose. The study from the dentofacial program of the University of Michigan revealed that the cephalometric measure, ANB angle, defining severe skeletal Class II and Class III patients did predict motivation level for orthodontics among patients (13). So far, no study investigated the relationship between the orthognathic need as assessed by IOFTN and the sagittal skeletal discrepancy. The main objective the present study is to ass the assess the relationship between the orthognathic need (IOFTN score) and the sagittal skeletal discrepancy (ANB angle).

## Materials and methods

The clinical records for 403 orthognathic patients (229 female and 174 male, aged 16-50 years) was used for the present investigation. For the present study, we used the data from three studies that investigated the use of IOFTN and reported on orthognathic surgeries in three samples: two from Iran (n=203) (15-17) and one from Turkey (n=200) (18).

The following variables were available and used for the present study;

*Malocclusion*

This was classified based on the British standard incisor classification (19) as follows:

Class I: The lower incisal edges occlude with or lie immediately below the cingulum of the upper incisors.

Class II division I: The lower incisal edge occludes behind the cingulum of the upper central incisors and the upper incisors are proclined.

Class II division II: The lower incisal edge occludes behind the cingulum of the upper central incisors, and the upper incisors are retroclined.

Class III: The lower incisal edge occludes in front of the cingulum of the upper incisors.

For this study we presented the data as Class I, Class II (combined Class II division I and II) and Class III

*Index of Orthognathic Functional Need (IOFTN)*

The IOFTN consists of five categories (Very Great Need, Great Need, Moderate Need, Mild Need, and No Need) and each category has subgroups. Assessment begins at the fifth category and ends at the first category. The full detail of the IOFTN scoring system is available on the open access journal (13)

*Sagittal Skeletal Relationship*

The cephalometric variable of ANB angle [A point (Subspinale) – Nasion – B point (Supramentale)] used to measure the relative position of the maxilla to mandible (Figure 1). The ANB angle can be also calculated from the formula: ANB = SNA-SNB. The A-point–nasion–B-point (ANB) angle is a commonly used variables for determining sagittal skeletal relationship (20). In order to determine the sagittal skeletal relationship, we used the ANB angles as Class I ($1° \leq ANB \leq 4°$), Class II ($ANB > 4°$), and Class III ($ANB < 1°$).

*Statistical Analysis*

The SPSS statistical software (IBM SPSS Statistics 28; IBM Corp., Chicago, IL, USA) was utilized for the statistical analysis. Histogram of ANB angles in the sample and the scatter plot of IOFTN scores vs. ANB angles in the sample as well as in different malocclusion groups were produced. The Spearman correlation coefficient (r) was used to assess the relationship between the IOFTN scores and the ANB angles.

Finally, regression studies were carried out to assess the percentages of the variation in IOFTN scores that is explained by variation in ANB angles. The level of significance was set at $p < 0.05$.

**Results**

Overall, in this sample, Class III malocclusion and Class III sagittal skeletal pattern were the most prevalent (62.3%), followed by Class II malocclusion (28%) and Class II sagittal skeletal pattern (30.5%), with Class I malocclusion being the least prevalent (9.7%) along with Class I sagittal skeletal pattern (7.2%). Figure 2 shows the histogram of ANB angles in the study sample. Figure 3 demonstrates the scatter plot of IOFTN scores vs. ANB angles, including the regression line. Figure 4 demonstrates the scatter plot of IOFTN scores vs. ANB angles in different malocclusion groups (Class I, II, and III).

The Spearman correlation coefficient (r) for the whole sample was -0.297 ($P<0.001$) indicating significant negative relationship. The linear regression analysis revealed that the coefficient of determination ($R^2$) was 0.069; therefore, about 6.9% of the variation in IOFTN data is explained by ANB angle variations. When data was split into different malocclusions, the coefficient of determination were 0.065, 0.034, and 0.089 for Class I, II, and Class III malocclusions, respectively.

**Discussion**

Functional evaluation in patients with dentofacial deformities encompassed an analysis of chewing and swallowing forces, maximum bite force, occlusal forces, occlusal changes, and occlusal contact area (21). Notably, investigations comparing pre- and post-treatment functional parameters spanning 1-3 years subsequent to orthognathic surgery have underscored varying outcomes (21). This retrospective study assessed the associations between the IOFTN scores (orthognathic treatment need) and ANB angles (sagittal skeletal discrepancy) in a sample of Turkish and Iranian adult orthognathic population. Similar to other occlusal indices (22-24), IOFTN does not assess the sagittal, vertical or transverse skeletal discrepancy, and therefore, the findings of weak association between the IOFTN scores and ANB angles in the present study are not unusual. There are also more dimensions to skeletal discrepancy, i.e., vertical and transverse dimensions, and we only assessed one aspect which was the sagittal skeletal discrepancy. Future studies can investigate these dimensions and its relationship with IOFTN. According to the present findings, only 6.9% of the variation in IOFTN data is explained by ANB angle variations. The correlation study revealed a statistically significant relationship between the IOFTN scores and ANB angles, but it was a weak linear association and not clinically relevant (25). In addition to spearman correlation coefficient, we also used the scatter plot and the pattern did not show a specific relationship between the IOFTN score and ANB angles. The negative correlation could be because of the higher proportion (62.3%) of subjects with Class III skeletal relationships in the present sample that attract negative ANB angles.

Previous studies highlighted the IOFTN issues including the lack of assessment of sagittal, vertical or transverse skeletal discrepancy. This may contribute to not identifying as high as 21% of subjects that benefit from orthognathic surgery (26,27). This could have implications in countries where they consider the occlusal features or cephalometric values with two or more standard deviation from published norms as medically appropriate and affect the insurance cover for these patients (5). As suggested the IOFTN should be used in combination with appropriate psychological and maxillofacial morphometric indicators (13, 28). The determination of indications for orthognathic surgery using IOTN is primarily based on occlusal findings and not on maxillofacial morphological analysis (13,15, 28).

As previously suggested (13,15), for the international application of IOFTN, a proposed modification to the IOFTN could be an exclusion of patients with well-compensated malocclusions that score low with IOFTN or those who have undergone previous orthodontic treatment and present a dentofacial skeletal deformities, including chin deficiency. It is also important to identify patients exhibiting mild to moderate dentofacial skeletal deformities and extreme occlusal deviations (e.g., proclination or retroclination of incisors) that do not require orthognathic correction but score high on IOFTN. In the context of these patients, diagnostic imaging utilizing cephalometric assessment to evaluate sagittal, vertical, or transverse skeletal disparities offers an invaluable adjunctive tool for identifying candidates likely to benefit from orthognathic surgery (13). This is particularly pertinent in scenarios where financial resources are limited and allocated exclusively to individuals deemed medically suitable, as determined by cephalometric measurements deviating two or more standard deviations from established norms (5).

A limitation of the present study was the retrospective nature of the sample collection that could lead to some selection bias. Future investigation ideally should be prospective in nature to overcome this shortcoming.

## Conclusion

the findings suggest that the *linear* associations between the sagittal skeletal discrepancy (ANB angle) and the IOFTN score was weak are not clinically relevant as reflected by small correlations coefficient and coefficients of determination. This could have implications for international use of IOFTN.

## Author contribution:

Hatice Kübra Olkun, Ladan Eslamian, Faezeh Eslamipour : Data curation

Ali Borzabadi Farahani: Conception, methodology and study design, determining the variables of the interest to be collected for the study, double checking the recorded occlusal traits, producing the scores for IOFTN, statistical analysis, writing the first draft including the literature review and discussion, as well as the subsequent versions of the article.

## Figure legends

Figure 1-The ANB angle (°) was used to classify the sagittal skeletal relationship as follows: Class I (1°< ANB <4°), Class II (ANB >4°), and Class III (ANB <1°)

Figure 2-The histogram of ANB angles in the study sample (n=403).

Figure 3-The scatter plot of IOFTN scores vs. ANB angles, including the regression line, in the study sample (n=403).

Figure 4-The scatter plot of IOFTN scores vs. ANB angles in different malocclusions (Class I, II, and III).

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