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PREVALENCE OF PERIODONTAL AND SKELETAL RISK FACTORS IN ORTHOGNATHIC SURGERY CANDIDATES: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Undiagnosed periodontal disease is prevalent in patients presenting for orthognathic surgery. However, the interaction between specific skeletal deformities and periodontal risk is poorly elucidated. Failure to identify these co-morbidities before osteotomy may adversely affect surgical predictability and long-term dentofacial stability. The purpose of the present study was to evaluate the prevalence and distribution of periodontal disease among adult patients evaluated for orthognathic surgery and to determine if skeletal classification and associated dentoalveolar characteristics are independent risk factors for moderate-to-severe periodontitis.

Materials and Methods: A cross-sectional study was carried out on 312 consecutive patients (174 females, 138 males; mean age 26.4 ± 7.2 years) referred to a tertiary university hospital for combined orthodontic-surgical assessment. Periodontal examination included full mouth probing pocket depth (PPD), clinical attachment loss (CAL), bleeding on probing (BOP), and plaque control record. Skeletal pattern was classified according to cephalometric ANB divergence into Class I, II or III. Other variables recorded included mandibular plane angle, lower incisor inclination, posterior crossbite, and open bite. Statistical analyses included chi-square, one-way ANOVA and multivariable logistic regression analysis with $P < 0.05$ as a threshold for significance.

Results: Forty-eight percent and four tenths percent (48.4%, n=151) of candidates presented with some stage of periodontitis and 19.9% (n=62) had stage III or IV disease. The most common pattern was Skeletal Class III malocclusion (42.0%, n = 131) and was significantly associated with localised attachment loss in the mandibular anterior segment (mean CAL 2.8 ± 1.4 mm vs 1.6 ± 0.9 mm in Class II; $P < 0.001$). Multivariate analysis revealed age >=30 years (adjusted OR 3.42; 95% CI: 1.78-6.57), current smoker (adjusted OR 2.89; 95% CI: 1.54-5.43), skeletal Class III (adjusted OR 2.15; 95% CI: 1.16-3.98), and posterior crossbite (adjusted OR 1.94; 95% CI: 1.03-3.66) as independent predictors for moderate-to-severe periodontitis.

Conclusion: About one-fifth of patients seeking orthognathic surgery have moderate-to-advanced periodontal disease before treatment. Skeletal Class III pattern appears to provide a unique periodontal risk profile, probably due to pre-surgical dental compensation and thin alveolar housing. A full periodontal screening should be mandatory in the orthognathic work-up especially in elderly patients, smokers and skeletal discrepancies involving mandibular prognathism.

Keywords: Periodontal disease, Orthognathic surgery, Skeletal malocclusion, Class III malocclusion, Risk factors, Cross-sectional study

INTRODUCTION

Orthognathic surgery is one of the most challenging yet gratifying procedures in the field of oral and maxillofacial surgery, which provides definitive correction of dentofacial deformities that cannot be addressed by orthodontics alone.[1,2] For the past two decades, surgical precision and rigid internal fixation have greatly improved post-operative stability,[3] but the long-term success of these interventions is intrinsically linked to the pre-existing health of the periodontium that supports the teeth that are to be repositioned during the treatment.

Periodontal disease is a major cause of tooth loss worldwide and the incidence of periodontal disease in adults seeking specialised dental care is greater than that in the general population.[4,5] This problem is exacerbated by several unique anatomical considerations within the orthognathic population. Skeletal discrepancies often require significant orthodontic tooth movement prior to osteotomy; decompensation in Class III patients, for example, often involves proclination of mandibular incisors that are already embedded in a thin labial alveolar plate.[4,6] Movement of these can unmask fenestrations or dehiscences predisposing to accelerated attachment loss post-operatively.

Despite these biological realities, routine periodontal assessment is not universally standardised among orthognathic treatment centers. Some surgeons use methods which are not sensitive enough to detect early or even moderate periodontal breakdown, such as gross visual inspection or panoramic radiography.[7] Moreover, prior studies have dealt with periodontal health either in a purely orthodontic population,[8] or in post-surgical follow-up cohorts.[9] There is therefore a clear gap in knowledge regarding the baseline periodontal status of patients at the very outset of the combined surgical-orthodontic journey. Cross-sectional data mapping periodontal pathology onto specific skeletal patterns could inform more nuanced pre-treatment protocols. For example, if there is an intrinsically increased burden of inflammation in some malocclusions, resources for preventive periodontal therapy could be directed accordingly. The present study was designed in this context to characterise the prevalence of periodontal disease among candidates for orthognathic surgery and to test the hypothesis that skeletal classification and associated dentoalveolar variables are an important risk factor for moderate to severe periodontitis in this population.

MATERIALS AND METHODS

Study Design and Setting: This was a cross-sectional observational study conducted in the Department of Dentistry of a tertiary academic medical center during 2024 - 2025 period. All participants provided written informed consent. Reporting is based on the STROBE guidelines for cross-sectional research.

Participant Selection: Patients 18–45 years of age referred for combined orthodontic-orthognathic evaluation were consecutively screened for eligibility. Inclusion criteria were the presence of a relevant skeletal discrepancy (ANB $\leq -2°$ or $\geq 4°$) or vertical dysplasia (SN-MP $\geq 40°$ or $\leq 28°$) with a stated treatment plan of bimaxillary or single jaw osteotomy. Exclusion criteria were previous periodontal surgery within the last 12 months, active orthodontic treatment at the time of assessment, less than 20 natural teeth, and systemic conditions known to profoundly influence periodontal status (uncontrolled diabetes mellitus, aggressive periodontitis of childhood onset, or leukocyte disorders).

Clinical and Radio graphic Examination: All measurements were performed by the same calibrated examiner (board certified periodontist, kappa = 0.87 for intra-examiner reliability) under standard dental unit lighting and with a WHO periodontal probe (PCP-UNC 15). At six sites per tooth the following parameters were measured:

Plaque Index (PI) and Gingival Index (GI) were scored according to Silness and Löe,[10] and Lee,[11] respectively. Probing pocket depth (PPD) and clinical attachment level (CAL) were recorded to the nearest mm. Bleeding on probing (BOP) was considered present when bleeding occurred within 10 seconds of the probe being withdrawn. All patients had full-mouth intraoral periapical radiography. When indicated assessment was supplemented by bitewing radiographs in posterior sextants.

Periodontal staging and grading were classified according to the 2017 World Workshop classification.[12,13] For risk modelling purposes, patients were dichotomised into two groups: healthy gingiva or mild disease (no periodontitis/stage I) versus moderate-to-severe disease (stage II–IV).

Skeletal and Dentoalveolar Variables: Lateral cephalometric radiographs were digitised in natural head position (Dolphin Imaging, version 11.9). The skeletal pattern was classified as Class I ($1° \leq$ ANB $\leq 3°$), Class II (ANB > 3°), or Class III (ANB < 1°) using the ANB angle . The vertical dimension was classified into normodivergent (28°-37°), hypodivergent (< 28°) or hyperdivergent (> 37°) according to the mandibular plane angle (SN-MP). The study models and clinical examination recorded lower incisor proclination (IMPA > 99o) and the presence of posterior crossbite or anterior open bite.

Statistical Analysis: Data were entered into SPSS (version 28.0; IBM Corp., Armonk, NY). Continuous variables were expressed as mean ± standard deviation (SD) and categorical variables as frequencies and percentages. Normality was assessed with the Shapiro-Wilk test. Group comparisons employed one-way ANOVA or Kruskal-Wallis tests for continuous data, and chi-square or Fisher exact tests for categorical variables. A multivariable logistic regression model was constructed to identify independent risk factors for moderate-to-severe periodontitis; variables with P < 0.10 in bivariate screening were entered using a forward stepwise (Wald) approach. Model fit was assessed with the Hosmer-Lemeshow test. Statistical significance was set at P < 0.05.

RESULTS

A total of 312 patients fulfilled the inclusion criteria and completed the full examination protocol. Table 1 summarises the demographic and skeletal profile of the cohort. The mean age was 26.4 years with a slight preponderance of females (55.8%). The most frequent deformity was Skeletal Class III (42.0%) followed by Class II (37.8%). About 25% of the sample reported current or previous tobacco use and only 31.1% had optimal plaque control (full-mouth PI <20%).

Periodontal health outcomes stratified by skeletal classification are shown in [Table 2]. Overall, 48.4% (n = 151) of the cohort met criteria for periodontitis at any stage. The moderate-to-severe disease (stage II–IV) was significantly uneven distributed among skeletal groups: 39.7% in Class III versus 22.0% in Class II and 19.0% in Class I (P = 0.003). Mean CAL was highest in the Class III group (2.8 mm) and these patients also had the highest mean PPD. Interestingly, plaque accumulation was not significantly different between the three skeletal categories, but BOP positivity was significantly higher in Class III patients (62.6% vs 51.7% in Class II and 47.6% in Class I; P = 0.048).

Table 1: Demographic, behavioral, and skeletal characteristics of the study population (n= 312).

Characteristic	n (%)	Mean ± SD or Median (IQR)
Age (years)	—	26.4 ± 7.2
18–24	142 (45.5)	—
25–29	89 (28.5)	—
30–45	81 (26.0)	—
Gender (female)	174 (55.8)	—
Current smoker	68 (21.8)	—
Former smoker	31 (9.9)	—
Plaque Index (% surfaces)	—	38.4 ± 21.7
Skeletal classification		
Characteristic	n (%)	Mean ± SD or Median (IQR)
Class I	63 (20.2)	—
Class II	118 (37.8)	—
Class III	131 (42.0)	—
Vertical pattern		
Hypodivergent	71 (22.8)	—
Normodivergent	156 (50.0)	—
Hyperdivergent	85 (27.2)	—
Posterior crossbite	94 (30.1)	—
Anterior open bite	47 (15.1)	—
Lower incisor proclination (IMPA > 99°)	156 (50.0)	—

SD, standard deviation; IQR, interquartile range; IMPA, incisor mandibular plane angle.

Table 2: Periodontal parameters by skeletal classification (n = 312).

Periodontal Variable	Class I (n=63)	Class II (n=118)	Class III (n=131)	P- value
Plaque Index (%)	36.2 ± 19.8	37.5 ± 22.1	40.1 ± 22.4	0.412
Gingival Index	0.82 ± 0.41	0.89 ± 0.48	0.97 ± 0.52	0.198
Bleeding on probing (%)	47.6	51.7	62.6	0.048a
Mean PPD (mm)	2.3 ± 0.5	2.5 ± 0.7	2.9 ± 0.9	<0.001a
Mean CAL (mm)	1.6 ± 0.9	1.6 ± 0.9	2.8 ± 1.4	<0.001a
Periodontal diagnosis, n (%)				
Periodontal Variable	**Class I (n=63)**	**Class II (n=118)**	**Class III (n=131)**	**P- value**
Clinically healthy / gingivitis only	38 (60.3)	64 (54.2)	59 (45.0)	0.112
Stage I periodontitis	13 (20.6)	28 (23.7)	20 (15.3)	0.214
Stage II–IV periodontitis	12 (19.0)	26 (22.0)	52 (39.7)	0.003a

PPD, probing pocket depth; CAL, clinical attachment loss. aSignificant at P < 0.05 (one-way ANOVA or chi-square test, as appropriate).

The site-specific analysis showed that the mandibular anterior segment contributed disproportionately to the attachment loss in Class III patients. In this group, 44.3% had at least one site with CAL ≥ 4 mm in the lower incisor or canine region versus 18.6% in Class II patients and 15.9% in Class I patients (P < 0.001). In contrast, mean CAL at maxillary posterior interproximal sites was not significantly different between groups.

Skeletal and dentoalveolar variables were assessed for association with the dichotomised periodontal outcome (stage II–IV vs no disease/stage I). Several factors were significant in bivariate screening and were subsequently entered into the regression model [Table 3]. Age ≥ 30 years, current smoking, skeletal Class III, posterior crossbite, and lower incisor proclination were associated with P values < 0.10 and therefore were included in the multivariable analysis.

Table 3: Bivariate analysis of risk factors associated with moderate-to-severeperiodontitis (stage II–IV).

Variable	OR	95% CI	P-value
Age ≥ 30 years (ref: <30)	3.71	2.04–6.75	<0.001
Male gender (ref: female)	1.46	0.84–2.55	0.179
Current smoker (ref: never)	3.24	1.78–5.90	<0.001
Skeletal Class III (ref: Class I/II)	2.38	1.35–4.19	0.003
Hyperdivergent pattern (ref: normo/hypo)	1.32	0.72–2.42	0.368
Posterior crossbite (ref: absent)	2.01	1.14–3.54	0.016
Anterior open bite (ref: absent)	1.29	0.62–2.68	0.498
Lower incisor proclination (ref: normal)	1.78	1.02–3.10	0.042

OR, odds ratio; CI, confidence interval.

[Table 4] shows the final logistic regression model. After adjustment for confounders, four variables remained independently predictive. The odds were highest for age ≥ 30 years (adjusted OR 3.42) and for current smoking (adjusted OR 2.89). Skeletal Class III remained a significant predictor (adjusted OR 2.15; 95% CI: 1.16–3.98) and so was the presence of a posterior crossbite (adjusted OR 1.94). In the bivariate analysis lower incisor proclination was significant but was collinear with skeletal class III and was dropped from the final model in the stepwise selection. The Hosmer-Lemeshow test indicated good fit of the model (P = 0.312).

Table 4: Multivariable logistic regression model for moderate-to-severe periodontitis.

Variable	Adjusted OR	95% CI	P-value
Age ≥ 30 years	3.42	1.78–6.57	<0.001
Current smoker	2.89	1.54–5.43	0.001
Skeletal Class III	2.15	1.16–3.98	0.015
Posterior crossbite	1.94	1.03–3.66	0.040

AreaunderROCcurve=0.741(95%CI:0.683–0.799).

DISCUSSION

This cross-sectional study yielded a sobering reality: nearly half of all patients evaluated for orthognathic surgery had some degree of periodontitis, and one in five had moderate-to-advanced disease that would almost certainly complicate both orthodontic decompensation and subsequent surgical repositioning if untreated. These prevalence figures are substantially higher than those reported in recent general adult populations,[14] supporting the notion that the orthognathic cohort is not merely a cosmetic-seeking subgroup but a medically distinct population with increased susceptibility to inflammatory periodontal disease.

The most clinically relevant finding was the disproportionate burden of attachment loss in skeletal Class III malocclusion patients. Class III pattern was identified as an independent risk factor with an increased odds ratio of more than two-fold for moderate-to-severe periodontitis after adjustment for age, smoking and other dentoalveolar confounders. This result is consistent with the anatomical rationale provided by previous investigators.[4,6] In Class III patients, mandibular incisors are often proclined pre-operatively beyond the confines of the alveolar housing to mask the underlying skeletal discrepancy resulting in thin labial bone or frank dehiscence. This mechanism is supported by our site-specific data, the disproportionate CAL was found almost exclusively in the mandibular anterior segment, precisely where compensatory proclination carries the greatest biologic cost.

However, it is important to note that there was no significant difference in plaque control among the skeletal classifications. This is an important finding as it suggests that the periodontal susceptibility in Class III patients may not be due solely to poor motivation or technique of oral hygiene, but to an environment which is anatomically restricted in such a way that the same amount of plaque produces more clinically destructive consequences. In periodontal parlance, the host site seems to alter the disease course regardless of microbial challenge.[15] This should be interpreted by clinicians as meaning that Class III patients with apparently acceptable oral hygiene still require meticulous periodontal surveillance and, when indicated, targeted regenerative or soft tissue augmentation prior to orthodontic tooth movement.

It is also worth noting the identification of posterior crossbite as an independent risk factor. Crossbites change the direction of occlusal forces and can result in plaque-retention irregularities of the buccal segments, particularly in the presence of a narrow maxillary arch.[16] Although crossbite is often considered mainly a transverse orthodontic problem, our data suggest that it should also trigger a periodontal vigilance. A longitudinal mechanistic investigation is needed to determine whether the association observed here is due to mechanical trauma, plaque accumulation in inaccessible embrasures, or both.

It's not surprising that smoking and older age are predictors, but noteworthy in the context of surgery. Both are theoretically modifiable or at least easily identifiable before osteotomy. Smoking cessation protocols instituted in the pre-surgical orthodontic phase have been shown to improve wound healing and reduce post-operative complications.[17]. Our findings add periodontal preservation to the list of compelling reasons for implementation of such interventions aggressively. Similarly, patients aged >30 years may be considered as high-priority referral for full-mouth periodontal charting regardless of self-reported dental history.

Our estimates of prevalence are at the upper end of the range reported in the previous literature. Kloehn and Pfeifer.[5] reported periodontal breakdown in one-third of orthognathic candidates in an early and well-cited study, whereas Al-Azemi and Artun.[8] found severe disease in only 8% of a younger orthodontic sample. The differences are likely to be due to differences in diagnostic thresholds, demographic composition and the fact that current classification systems (2017) identify attachment loss at lower thresholds than previous protocols.[12] However, the weight of evidence now indicates a substantial baseline burden of periodontitis in this treatment population.

There are a few limitations that should be noted. The cross-sectional design does not allow us to draw conclusions about causality and does not allow us to determine whether skeletal patterns predispose to periodontal disease or whether shared developmental or behavioural antecedents underlie both conditions. Our sample was also drawn from a single tertiary referral center and may not fully represent community practice settings or regional ethnic variations in craniofacial morphology. The examiner was not blinded to the cephalometric diagnosis during periodontal charting, which theoretically could have exposed the study to a risk of detection bias. All efforts were made, however, to standardise probing force and angulation. Finally, microbial sampling was outside the scope of this investigation and therefore, we cannot comment on whether differences in subgingival biofilm composition contributed to the skeletal group differences.

From a clinical point of view, these data support the implementation of a formal interdisciplinary periodontal risk assessment as a mandatory part of the orthognathic work-up. At minimum, full-mouth periodontal charting, radiographic bone level assessment and risk stratification with the variables identified herein should occur prior to appliance placement. High risk patients (older, smokers, Class III malocclusion, posterior crossbite) may be considered for staged periodontal therapy including subgingival debridement, chemical plaque control and guided tissue regeneration in the presence of alveolar dehiscence prior to the application of orthodontic movement.[18]

CONCLUSION

In this cross-sectional study, orthognathic surgery candidates had a significantly higher prevalence of periodontal disease, with approximately 20% of patients presenting moderate-to-advanced attachment loss at baseline. Skeletal Class III malocclusion was identified as an independent risk factor for clinically significant periodontitis most likely representing the periodontal susceptibility associated with presurgical incisor decompensation and thin anterior alveolar housing. Known risk factors include smoking and increasing age . The presence of a posterior crossbite also contributes to periodontal susceptibility . The results highlight the importance of a comprehensive periodontal assessment and risk-adjusted intervention in the orthognathic treatment pathway, especially for those patients whose skeletal pattern exposes them to risk for localised attachment loss in the mandibular anterior region.

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