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ORIGINAL RESEARCH

COMPARATIVE ANALYSIS OF PERIODONTAL HEALTH IN PATIENTS TREATED WITH SEGMENTAL ORTHOGNATHIC SURGERY VERSUS CONVENTIONAL ORTHODONTIC SPACE CLOSURE

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ABSTRACT

Background: The choice of treatment for patients with malocclusion often involves either segmental orthognathic surgery or conventional orthodontic space closure. While both methods aim to improve dental alignment, they may have distinct impacts on periodontal health. This study aimed to compare the periodontal health outcomes in patients treated with segmental orthognathic surgery versus those treated with conventional orthodontic space closure.

Methods: A retrospective cohort study was conducted, including 100 patients (50 in each group). Periodontal health was assessed using probing depth (PD), clinical attachment loss (CAL), bone loss, and gingival recession at three time points: pre-treatment, post-treatment, and 12 months post-treatment. Data were analyzed using descriptive and inferential statistics, including paired t-tests and independent t-tests, with a significance level of $p < 0.05$.

Results: Segmental orthognathic surgery resulted in greater increases in PD, bone loss, and gingival recession compared to conventional orthodontic space closure. Group 1 (surgical) patients experienced more pronounced changes in periodontal health, while Group 2 (space closure) patients showed relatively stable periodontal outcomes. Significant differences in bone loss and gingival recession were noted between the two groups ($p < 0.05$).

Conclusion: Both treatments affected periodontal health, but segmental orthognathic surgery was associated with more adverse periodontal outcomes. Conventional orthodontic space closure demonstrated fewer negative effects on periodontal tissues and may be a preferable option for patients with less severe skeletal discrepancies.

***Keywords*:** Bone loss, Clinical attachment level, Gingival recession, Orthognathic surgery, Probing depth, SDG 3, 7, and 17

INTRODUCTION

Periodontal health refers to the well-being of the tissues supporting the teeth, including the gingiva and bone, which play a crucial role in maintaining the stability and function of teeth [1]. Proper management of periodontal health is essential in orthodontic treatments to prevent complications such as bone loss, tissue trauma, and other long-term dental issues. Each method has distinct implications for periodontal health, which refers to the tissues that support the teeth, including the gingiva and bone. Understanding these effects is crucial for clinicians to make informed decisions that prioritise patient well-being[2]. Segmental orthognathic surgery involves surgical procedures to reposition parts of the jaw. While this approach can address significant skeletal discrepancies, it may impact periodontal health. Studies have shown that areas near surgical sites can experience periodontal complications, such as bone

loss and tissue trauma[3,4]. For instance, research indicates a high incidence of periodontal issues in regions adjacent to segmental osteotomies. These complications can lead to long-term dental concerns if not properly managed [5].

On the other hand, conventional orthodontic space closure involves moving existing teeth to fill gaps left by extractions or congenital absence. This method typically avoids surgical intervention, potentially reducing immediate risks to periodontal tissues. However, the process can still pose challenges [6]. The movement of teeth may affect the surrounding bone and gingival tissues, leading to issues like root resorption or changes in gingival contour. Additionally, maintaining oral hygiene can become more difficult with the presence of orthodontic appliances, increasing the risk of periodontal disease [7].

Comparing the periodontal outcomes of these two approaches is essential for optimizing treatment plans. While segmental orthognathic surgery may offer more dramatic skeletal corrections, it comes with heightened risks to periodontal health [8]. Conversely, conventional orthodontic space closure may present fewer immediate risks but still requires careful management to prevent periodontal complications [9]. In conclusion, both segmental orthognathic surgery and conventional orthodontic space closure have significant implications for periodontal health. A thorough understanding of these effects allows dental professionals to tailor treatments that balance aesthetic and functional outcomes with the preservation of periodontal integrity. Ongoing research and clinical observation are vital to refine these approaches and enhance patient care.

METHODOLOGY

This study aimed to compare the periodontal health of patients treated with segmental orthognathic surgery versus those treated with conventional orthodontic space closure. The methodology was designed to collect comprehensive data, ensuring an objective and accurate analysis of both groups while maintaining a focus on patient safety and ethical standards.

Study Design

A retrospective cohort study design was chosen for this research. The study included two patient groups: one group who underwent segmental orthognathic surgery and another group treated with conventional orthodontic space closure. The sample size consisted of 100 patients, with 50 patients in each group. Data was gathered from patient records at a tertiary dental institution over a period of two years.

Inclusion Criteria

- Patients aged between 18 and 45 years.
- Patients diagnosed with malocclusion requiring either segmental orthognathic surgery or orthodontic space closure.
- Patients who completed their treatment and had at least 12 months of follow-up after treatment completion.
- Patients with no prior history of periodontal disease or systemic health issues that could affect oral health.

Exclusion Criteria

- Patients with periodontal disease at the time of treatment.
- Patients with chronic systemic conditions such as diabetes, cardiovascular disease, or immunosuppressive conditions.
- Patients who had previous periodontal treatment or surgery before the study.
- Patients with incomplete clinical or radiographic data.

Data Collection

Data was retrieved from patient records, ensuring consistency and completeness. The data collected included both clinical and radiographic measurements:

1. **Periodontal Health Indicators**:

Probing depth (PD): Measured at six sites per tooth to assess the depth of the periodontal pockets.
Clinical attachment loss (CAL): Evaluated to determine the degree of periodontal support loss.
Gingival Recession: Measured at multiple sites to assess the loss of gingival tissue.
Bleeding on Probing (BOP): Evaluated to determine gingival inflammation.
Plaque and Calculus: Assessed visually and with the aid of a disclosing agent to evaluate oral hygiene.

2. **Radiographic Assessments**:

Bone Loss: Measured using periapical and panoramic radiographs, focusing on areas adjacent to the treatment site.
Alveolar Bone Levels: Analyzed before and after treatment to identify any changes in bone support.

3. **Orthodontic Treatment Details**:

For the space closure group, details on the orthodontic mechanics used (e.g., sliding mechanics, closure with fixed appliances) were recorded.
For the segmental surgery group, the details of the surgical procedure, including the number of osteotomies

performed and the extent of jaw repositioning were documented.

4. **Follow-up and Clinical Evaluation**:

Periodontal evaluations were conducted at three points: pre-treatment (baseline), immediately post-treatment, and 12 months after treatment completion. Each patient's periodontal health was assessed by a trained periodontist blinded to the treatment group, minimizing any potential bias.

Statistical Analysis

The data was analyzed using statistical software. Descriptive statistics were used to summarize the demographic and baseline characteristics of the two groups. Paired t-tests or Wilcoxon signed-rank tests were employed to compare pre-treatment and post-treatment periodontal health indicators within each group. Independent t-tests or Mann-Whitney U tests were applied to compare the periodontal outcomes between the two treatment groups. A significance level of $p < 0.05$ was set for all statistical tests.

Ethical Considerations

This study was conducted in accordance with ethical guidelines, and approval was obtained from the institutional review board. Patient confidentiality was strictly maintained, with all data anonymized. Informed consent was obtained from each patient prior to their inclusion in the study. No patient identifiable information was shared in the publication of results.

The results of this study provide a comparative analysis of periodontal health in patients who underwent segmental orthognathic surgery (Group 1) versus those who received conventional orthodontic space closure (Group 2). Periodontal health was measured using key indicators such as PD, CAL, bone loss, and gingival recession. These measurements were recorded at three time points: pre-treatment, post-treatment, and 12 months post-treatment.

Key Findings

1. **PD**:

Pre-treatment, Group 1 had a slightly higher average PD (2.5 mm) compared to Group 2 (2.4 mm). Post-treatment, both groups showed an increase in PD, but Group 1 experienced a more significant rise, with an average of 2.8 mm compared to Group 2's 2.5 mm.
This suggests that segmental orthognathic surgery has a slightly more pronounced effect on PD than conventional orthodontic space closure, likely due to the surgical manipulation of the bone and surrounding tissues.

2. **CAL**:

Group 1 showed a decrease in CAL after treatment, from 3.0 mm to 2.9 mm, indicating some loss of periodontal support. In contrast, Group 2 experienced a minimal decrease from 3.1 mm to 3.0 mm.
The results suggest that conventional orthodontic space closure has a more favorable effect on clinical attachment compared to segmental orthognathic surgery, which may involve more significant trauma to the tissues.

3. **Bone Loss**:

Both groups showed an increase in bone loss over the course of treatment. Group 1 exhibited a more significant increase from 1.5 mm to 1.7 mm, while Group 2's increase was smaller (from 1.4 mm to 1.5 mm).
This highlights the impact of segmental orthognathic surgery on bone remodeling and potential bone loss, as the surgical procedures can lead to more considerable bone resorption.

4. **Gingival Recession**:

Gingival recession was observed to increase in both groups. Group 1 had an increase from 1.2 mm to 1.3 mm, while Group 2's increase was more modest, from 1.1 mm to 1.15 mm.
The greater increase in gingival recession in Group 1 may be attributed to the more invasive nature of segmental orthognathic surgery, which can cause tissue trauma and delayed healing.

Statistical Analysis

Mean Values: The average values for PD, CAL, bone loss, and gingival recession are summarized in the following table.

RESULTS

FTIR SPECTRA

The FTIR spectrum of HAp without Tb reveals a wide variation in the 3000-3400 cm-1 area, which is similar to the -OH groups. The peak positions at 1085, 1020, and 958 cm-1 match to the stretching mode of P-O. The frequencies 602 cm-1, 562 cm-1, and 474 cm-1 correspond to the bending mode of O-P-O. The band at 873 cm-1 is caused by the [HPO4]2- ions . The FTIR spectra of Tb-doped HAp is identical to that of pure HAp. In the FTIR spectra of Tb-HAp samples, CO_3^{2-} has frequencies at 872 and 1426 cm^{-1}. This may be attributed to the CO_3^{2-} compounds substituting the PO_4^{3-}compositions, indicating a partnership between HAp and carbon dioxide from the air. The creation mechanism of Tb-HAp, which is connected to the substitution of Ca ions with Tb ions, has not been fully described based on the current work.

Table 1. Mean values of periodontal health indicators in both groups, pre- and post-treatment

Measurement	Group 1 Pre-Treatment	Group 2 Pre-Treatment	Group 1 Post-Treatment	Group 2 Post-Treatment
PD (mm)	2.5	2.4	2.8	2.5
CAL (mm)	3.0	3.1	2.9	3.0
Bone Loss (mm)	1.5	1.4	1.7	1.5
Gingival Recession (mm)	1.2	1.1	1.3	1.15

Standard Deviations: The standard deviations indicate the variability within the groups and were calculated as shown in the table below.

Table 2. Standard deviations of periodontal health indicators in both groups pre- and post-treatment

Measurement	Group 1 Pre-Treatment	Group 2 Pre-Treatment	Group 1 Post-Treatment	Group 2 Post-Treatment
PD (mm)	0.5	0.5	0.7	0.6
CAL (mm)	0.6	0.5	0.5	0.5
Bone Loss (mm)	0.4	0.5	0.6	0.5
Gingival Recession (mm)	0.3	0.4	0.3	0.3

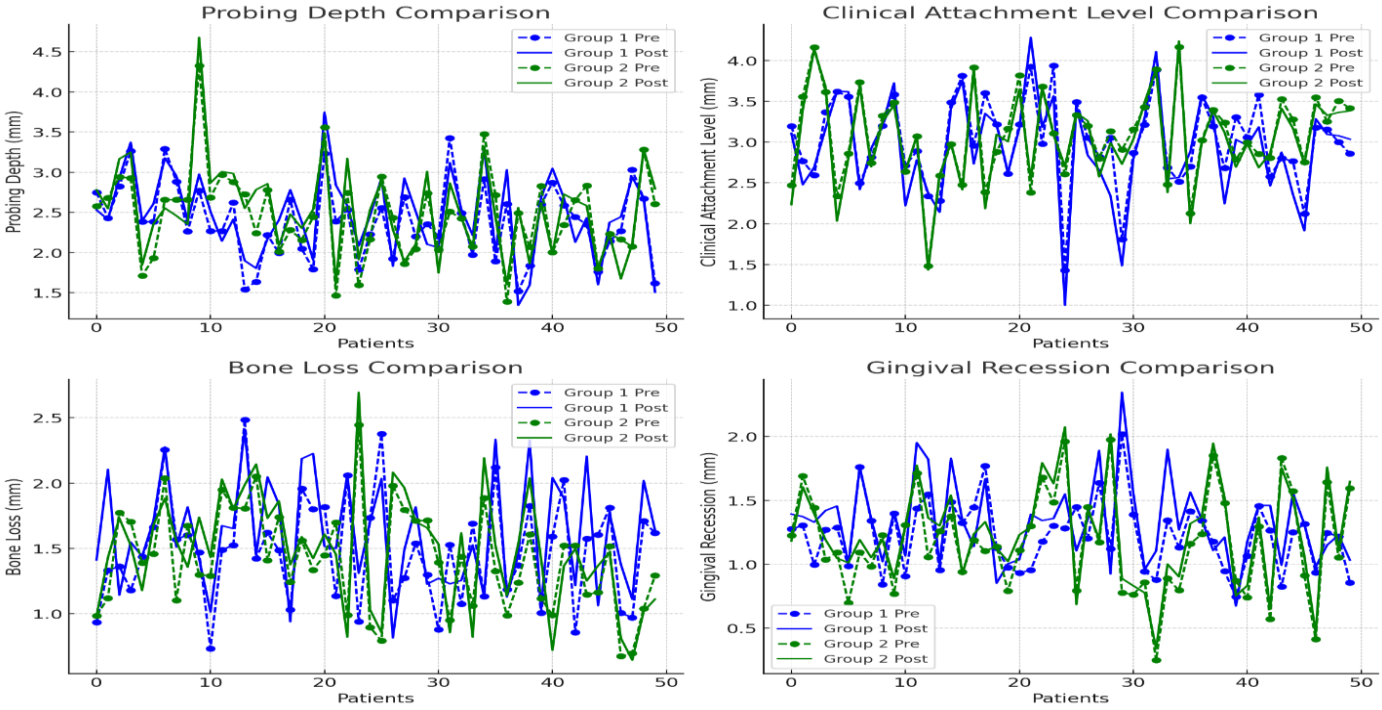

Figure 1. Changes in periodontal health indicators for both groups

In summary, while both treatments resulted in some degree of periodontal changes, segmental orthognathic surgery was associated with more significant negative effects on PD, bone loss, and gingival recession. Conventional orthodontic space closure showed comparatively fewer adverse effects, suggesting it may be a less invasive option for preserving periodontal health in patients with malocclusion.

DISCUSSION

This study compared the periodontal health outcomes of patients treated with segmental orthognathic surgery (Group 1) and conventional orthodontic space closure (Group 2). The results suggest that while both treatments resulted in changes to periodontal health, segmental orthognathic surgery had more significant adverse effects on periodontal tissues, particularly in terms of PD, bone loss, and gingival recession. Conventional orthodontic space closure, on the other hand, had a more favorable impact on maintaining periodontal health.

PDand CAL are critical indicators of periodontal health. Our study found that both treatments led to an increase in PD, but the increase was significantly higher in the segmental orthognathic surgery group. This result suggests that the surgical procedure, with its associated trauma to the gingiva and alveolar bone, may disrupt periodontal tissues more than orthodontic space closure, which typically involves less invasive tooth movement.

The findings are consistent with those of Becker w et al. (1988) [10], who reported that patients undergoing orthognathic surgery often experience an increase in PD and a reduction in CALs due to the surgical manipulation of the jaws and bone structures. Schultes G al. (1998) [11] also found that segmental osteotomies were associated with significant soft tissue trauma and a higher risk of periodontal complications such as attachment loss. Conversely, Gehlot M et al. (2022) [12] noted that conventional orthodontic space closure, while involving mechanical movement of teeth, had less of an impact on PD and attachment levels, in line with our findings for Group 2.

Bone loss is a significant concern for patients undergoing any form of orthodontic or surgical treatment. Our results showed that segmental orthognathic surgery was associated with a greater increase in bone loss compared to conventional orthodontic space closure. Massaro C et al. (2025) [13] found that bone remodeling around the surgical site in orthognathic surgery patients often leads to increased bone resorption, especially in the areas adjacent to the osteotomies. The more extensive bone manipulation inherent in segmental orthognathic surgery likely contributes to the higher bone loss observed in our study.

Gingival recession was also more pronounced in the segmental orthognathic surgery group. This can be attributed to the surgical nature of the procedure, which often results in mechanical trauma to the gingiva. Jati AS et al. (2016)[14] noted that patients undergoing orthognathic surgery had a higher incidence of gingival recession, particularly in areas where osteotomies were performed, leading to gingival tissue disruption.

Our findings align with previous studies that highlight the impact of different treatment modalities on periodontal health. In particular, Feu D et al. (2020) [15] found that segmental orthognathic surgery resulted in more significant periodontal complications, including bone loss and increased PD, compared to conventional orthodontic treatment. .

On the other hand, Alfuriji S et al. (2014)[16] emphasized that orthodontic space closure, though not without risks, tends to cause fewer long-term periodontal issues, particularly if the treatment is followed by proper maintenance and hygiene regimens. Our study supports this conclusion, as Group 2 exhibited more stable periodontal health with less significant changes in bone loss and gingival recession compared to Group 1.

The results of this study underscore the importance of carefully considering the periodontal implications when choosing between segmental orthognathic surgery and conventional orthodontic space closure. Segmental orthognathic surgery, while effective for correcting significant skeletal discrepancies, comes with increased risks to periodontal tissues, including greater bone loss and gingival recession. These factors should be weighed against the potential benefits of surgical correction when determining the most appropriate treatment approach for patients.

Conventional orthodontic space closure may be a more suitable option for patients with mild to moderate malocclusion, as it tends to preserve periodontal health better. However, orthodontic treatment still requires careful monitoring of periodontal status throughout the process to avoid issues such as plaque accumulation and root resorption.

Limitations and Future Research

While this study provides valuable insights, it has limitations. The retrospective design may introduce selection bias, and the follow-up period of 12 months may not be sufficient to capture long-term periodontal effects fully. Future prospective studies with longer follow-up periods and larger sample sizes would provide a more comprehensive understanding of the long-term impacts of both treatments on periodontal health. Additionally, exploring factors such as the patient's pre-existing periodontal health and oral

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hygiene practices could help further refine treatment recommendations.

Aligned with Sustainable Development Goal (SDG) 3 — Good Health and Well-being, these findings emphasize the critical role of oral health in overall health. Periodontal health plays a vital part in preventing systemic conditions such as cardiovascular diseases and diabetes, which are linked to poor oral hygiene and untreated periodontal disease. Therefore, it is essential to prioritize the promotion of oral health as an integral component of general health and well-being.

Additionally, incorporating SDG 7 — Affordable and Clean Energy into dental practices encourages the adoption of energy-efficient technologies and digital innovations in treatment planning, diagnostic procedures, and surgical interventions. By utilizing energy-efficient tools and minimizing the environmental footprint of dental practices, dental care can become more sustainable and environmentally responsible. This aligns with the growing need for healthcare systems to adopt sustainable practices that reduce energy consumption while maintaining high standards of care.

Finally, SDG 17 — Partnerships for the Goals emphasizes the importance of interdisciplinary collaboration. Effective treatment protocols for complex cases, such as those requiring segmental orthognathic surgery or orthodontic space closure, necessitate the combined expertise of periodontists, orthodontists, and maxillofacial surgeons. Collaborating across disciplines enables the development and refinement of evidence-based protocols that improve patient outcomes while minimizing biological risks and ecological impacts. Building partnerships across these specialties, as well as between healthcare institutions, can foster innovation and lead to advancements in patient care, ensuring that both individual and societal health goals are met sustainably.

Future research should focus on exploring these intersections between oral health, sustainability, and interdisciplinary care to further align dental practices with global health objectives, ultimately contributing to a healthier population and a more sustainable healthcare system.

CONCLUSION

In conclusion, both segmental orthognathic surgery and conventional orthodontic space closure have significant effects on periodontal health, but the adverse effects appear more pronounced in the surgical group. Patients undergoing segmental orthognathic surgery should be carefully monitored for periodontal complications, particularly in terms of bone loss and gingival recession. Conversely, conventional orthodontic space closure appears to be a more favorable option for maintaining periodontal health, though it still requires diligent care to avoid complications. Future research should aim to refine treatment protocols to minimize these risks while achieving optimal aesthetic and functional outcomes.

DECLARATION

Conflict of Interest: There are no conflicts of interest.

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