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Impact of Orthodontic Space Management on the Success of Implant-supported Prosthesis

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ABSTRACT

One of the most important clinical decision-making areas is still the treatment of missing teeth using implant-supported prostheses and orthodontic space closure. Recent data shows that both approaches, when properly chosen, produce positive results. Treatment precision and predictability have increased thanks to developments in digital planning, TADs, and interdisciplinary approaches. While implants guarantee functional and aesthetic stability in adults, space closure offers biologically conservative solutions for developing patients. Individualised planning based on the patient's age, occlusion, and aesthetic requirements is essential for long-term success.

Introduction

For patients who need implant-supported prostheses, orthodontic space management is essential, particularly when maxillary lateral incisors and premolars are congenitally missing. In addition to being a functional issue, the loss of these teeth raises serious aesthetic concerns that may affect a patient's self-esteem and quality of life. Effective space management planning lays the groundwork for successful implant placement and long-term prosthesis stability by ensuring that restorative and orthodontic goals are met in harmony. Historically, one of the most dependable techniques has been orthodontic space opening, which enables the

creation of optimal alignment and spacing to support implant-supported restorations with predictable aesthetic results [1]. According to studies, proper space preparation enhances the emergence profile of implants, makes proper implant angulation easier, and reduces the possibility of biomechanical or cosmetic issues after restoration. Similarly, preserving or re-creating natural spacing guarantees that the prosthetic rehabilitation closely resembles natural dentition. Methodical analyses demonstrate the close connection between space management strategies and the ensuing occlusal and periodontal results [2]. By avoiding crowding or excessive spacing, which could otherwise put patients at risk for periodontal compromise, properly managed spaces

help maintain periodontal health. Additionally, whether the chosen approach—space opening or closure—aligns with the patient's skeletal and dental relationships has a significant impact on occlusal harmony and stability. By giving clinicians stable, minimally invasive anchorage, temporary anchorage devices (TADs) have revolutionised orthodontics [3]. The predictability of orthodontic space management is increased by these devices, which allow controlled tooth movement without significantly depending on patient compliance. They greatly increase clinical versatility by being useful for both space closure mechanics and space opening protocols prior to implant insertion. In these complicated cases, interdisciplinary cooperation has become a crucial factor in determining the success of treatment. Aesthetic, functional, and biomechanical considerations are all addressed at the same time when orthodontists, prosthodontists, and implantologists communicate effectively [4]. This partnership enhances patient-centered outcomes, lowers the risk of complications, and optimises treatment sequencing. The severity of agenesis, occlusal requirements, and patient-specific aesthetic demands all influence treatment trends, according to recent clinical analyses [5]. Orthodontic space management serves as the foundation for prosthetic rehabilitation in these situations, allowing for customised approaches. The crucial role of TADs in contemporary orthodontics is further highlighted by reviews of anchorage techniques, which extend their application beyond traditional mechanics to act as adjuncts in implant site preparation [6]. In the end, choosing a treatment modality is still very important. Long-term aesthetic harmony, periodontal integrity, and functional stability are all directly impacted by clinicians' choices regarding space closure or implant-supported prostheses [7]. A customised strategy that is informed by evidence-based protocols and interdisciplinary planning guarantees that results satisfy patient expectations as well as clinical standards.

Methodology

In order to assess the effect of orthodontic space management on the long-term success of implant-supported prosthetic rehabilitation in patients with congenitally missing maxillary lateral incisors and premolars, this study was designed as a retrospective observational analysis. Strict inclusion and exclusion criteria were used to select 50 patients in total from institutional records. Patients with a documented history of orthodontic space opening followed by implant placement or orthodontic space closure with subsequent prosthetic rehabilitation, a minimum follow-up period of two years following prosthesis delivery to evaluate long-term outcomes, and full access to clinical notes, radiographic records, and photographs were the requirements for inclusion. Patients

with untreated periodontal disease, a history of maxillofacial trauma at the implant site, systemic conditions affecting bone metabolism, or incomplete records that could jeopardise the reliability of the data were excluded. Demographic information (age, gender), space management type (space opening with implant-supported prosthesis vs. orthodontic space closure with prosthetic replacement), implant survival, prosthetic success, aesthetic performance, occlusal stability, and periodontal health status were among the categories into which the data were extracted from the records. The absence of mobility, pain, or peri-implant radiolucency, as well as radiographic bone loss of no more than 1.5 mm during the first year and 0.2 mm per year after that, were among the established criteria used to define implant survival. Functional integrity without chipping, breaking, or needing to be replaced during the follow-up period was considered a sign of prosthetic success. The Pink Aesthetic Score (PES) and White Aesthetic Score (WES) were used to objectively evaluate aesthetic outcomes, and patient records were used to gauge subjective aesthetic satisfaction. Based on established clinical evaluations of articulation and masticatory efficiency, occlusal function was assessed. Probing depth, bleeding indices, and peri-implant tissue status were used to evaluate periodontal health. Descriptive statistical analysis was performed on all of the collected data. A thorough summary of the clinical outcomes in both treatment modalities was given by the results, which were presented as frequencies, percentages, and mean values.

Results

Of the 50 patients in the study, 22 received orthodontic space closure treatment, and 28 received orthodontic space opening followed by implant-supported prosthetic rehabilitation. Given that 62% of the patients were female, the study population as a whole had a mean age of 23.7 ± 4.2 years, with a definite female predominance. This distribution is in line with earlier research showing that female patients have a greater aesthetic need for anterior dental rehabilitation. At 96.4%, implant survival was exceptionally high in the space-opening group. During the follow-up period, there was only one implant loss, which was ascribed to an early failure prior to osseointegration. Crucially, there was no indication of radiographic signs of progressive bone loss or mobility in the remaining implants, indicating long-term stability. In this group, 92.8% of prosthetics were successful. Although overall results were very positive, a small number of patients experienced minor complications. These included occasional screw loosening and porcelain veneer chipping in crowns supported by implants, both of which were controllable with regular care. The implant group's aesthetic performance was especially good. A mean combined score of 16.2 ± 1.3 was found using the Pink Aesthetic Score (PES) and White

Aesthetic Score (WES). This high value indicated favourable crown morphology, proper gingival contour, and superior pink tissue adaptation. In terms of smile aesthetics, the implant-supported prostheses improved patient satisfaction by blending in perfectly with the surrounding natural dentition. Functional results were equally significant in the space-closure group. Most patients experienced occlusal stability, and 90.9% of them reported no notable functional abnormalities, including interference, occlusal disharmony, or impaired mastication. This illustrated how well-executed space closure can offer superior long-term stability and functionality. In contrast to the implant group, aesthetic satisfaction was marginally lower. Because the morphology, size, and colour of canines did not always precisely resemble those of natural lateral incisors, this was especially noticeable in situations where canine substitution was used to replace missing lateral incisors. As a result, this group's mean PES/WES score was lower, at 14.1 ± 1.6 , highlighting the difficulties in obtaining optimal anterior aesthetics without implant replacement. Results for periodontal health were good for both groups, although the space-closure group showed a small advantage. 86.3% of patients who received orthodontic space closure treatment continued to have healthy periodontal conditions, which are indicated by shallow probing depths and little bleeding when probed. On the other hand, the implant group experienced favourable periodontal outcomes in 82.1% of cases. The implant group's slightly lower score might be explained by the peri-implant tissues' innate vulnerability to biological alterations, such as the possibility of bone remodelling or peri-implant mucositis. However, both groups showed results that were supportive of long-term oral health and clinically acceptable. The clinical results were further supported by patient-reported quality-of-life (QoL) outcomes. Significant improvements in oral function, aesthetics, and general psychosocial well-being were reported by a significant percentage of patients in both treatment groups. 88% of the implant group reported being satisfied with the overall results of the treatment, frequently citing the restored function and natural aesthetics as important aspects. In a similar vein, 82% of patients in the space-closure group expressed high levels of satisfaction, expressing special gratitude for the preservation of their natural dentition and the lack of maintenance requirements for prosthetics. The two treatment modalities are compared to show how well each complements the other. When positioned after orthodontic space opening, implant-supported prostheses produced excellent aesthetic results and high success rates for prosthetics. Conversely, although aesthetic compromises were more frequent, orthodontic space closure offered comparable functional stability and improved periodontal health. These findings highlight the significance of customised treatment planning, in which the selection of therapy must take into account the patient's expectations, aesthetic preferences, and long-term

maintenance requirements. Table 1 provides a summary of the relative results of the two methods, including improvements in patient-reported quality of life, occlusal stability, implant survival, prosthetic success, aesthetic evaluation, and periodontal health.

Table 1. Comparative Outcomes of Orthodontic Space Management Approaches (n = 50)

Outcome Measure	Space Opening + Implant (n = 28)	Space Closure (n = 22)
Implant survival rate (%)	96.4	–
Prosthetic success (%)	92.8	–
PES/WES score (mean $\pm$ SD)	16.2 ± 1.3	14.1 ± 1.6
Occlusal stability (%)	89.2	90.9
Esthetic satisfaction (%)	85.7	72.7
Periodontal health (favorable %)	82.1	86.3
Patient-reported QoL improvement (%)	88	82

Table 1: Comparative evaluation of functional, esthetic, and clinical outcomes between orthodontic space opening with implant placement and orthodontic space closure.

Discussion

One of the main topics of discussion in orthodontics and prosthodontics is how to treat missing teeth, especially maxillary lateral incisors and premolars. The literature is dominated by two main approaches: prosthetic replacement with implant-supported prostheses and orthodontic space closure. Both strategies have advantages and disadvantages of their own, requiring careful case selection and customised treatment planning [8]. Crowns supported by implants offer a prosthetic replacement option that closely resembles natural dentition in both appearance and functionality. Cone beam computed tomography (CBCT)-based CAD-CAM templates are one example of a technological advancement that has improved miniscrew placement accuracy, allowing for controlled tooth movement and better implant space preparation [9]. These developments increase accuracy and lower complications, which eventually results in more predictable prosthetic results. The significance of collaborative care between orthodontists and prosthodontists is highlighted by long-term studies suggesting that interdisciplinary treatment—combining orthodontic space preparation with implant prosthodontics—achieves superior results in terms of occlusal stability and function [10]. Conversely, in some clinical situations, orthodontic space

closure has gained support, especially when the functional and aesthetic requirements can be satisfied without the need for prosthetic replacements [11]. By choosing this option, implant-related risks like peri-implantitis, bone resorption, and aesthetic issues in cases of thin gingival biotypes are avoided. The choice between space closure and prosthetic replacement should be based on patient-specific considerations, such as age, facial aesthetics, and occlusion, according to narrative reviews [12]. For example, space closure is frequently chosen in growing patients in order to prevent implant placement prior to skeletal maturity, which could lead to infraocclusion or compromised aesthetics. The adaptability of orthodontic treatment has been greatly increased with the advent of temporary anchorage devices (TADs). TADs provide an adjunct to closure and implant site preparation by facilitating precise tooth movement and space management [13]. According to systematic reviews, the effectiveness of space closure in comparison to implant-based rehabilitation varies depending on the patient's needs and the location of the tooth [14]. While space closure may yield simpler, more stable results in posterior regions, implant-supported prostheses may offer superior aesthetic integration in anterior aesthetic zones. The significance of long-term aesthetic stability in directing treatment selection is continuously emphasised in clinical studies contrasting the two approaches [15]. While prosthetic replacement offers the benefit of tooth-like restorations with high aesthetic fidelity, space closure, when done correctly, can produce predictable functional and aesthetic results. In situations where traditional space closure or implant placement may not be practical, emerging technologies have also been presented as potential alternatives, such as digitally guided autotransplantation [16]. Moreover, ridge mini-implants have proven useful in offering anchorage and extending treatment options beyond conventional techniques, particularly when splinted [17]. The validity of space closure as a long-term solution is supported by retrospective evaluations, which reveal positive functional and aesthetic outcomes in a subset of patients [18]. The range of implant-based techniques is being expanded by the investigation of non-traditional implant strategies in situations where interocclusal space is restricted [19]. Preprosthetic orthodontics, which is essential for creating ideal implant sites, is another important factor affecting prosthetic results. Proper orthodontic space management greatly increases prosthesis stability and long-term implant survival, according to systematic reviews [20]. Orthodontic micro-implants' survival rates are further highlighted by retrospective analyses, which also emphasise patient-related factors that affect treatment success, such as bone density and oral hygiene [21]. In conclusion, implant-supported prostheses and orthodontic space closure are both legitimate, research-based methods of replacing lost teeth. Orthodontic space closure provides a biologically conservative and frequently aesthetically pleasing alternative,

especially for younger patients, even though implants are still the best option for functional and aesthetic replacement in adults. The patient's age, skeletal maturity, occlusion, desired aesthetics, and long-term functional requirements should all be taken into consideration when choosing between these approaches. In the end, customised multidisciplinary treatment planning guarantees that patients gain the aesthetic integrity and functional dependability necessary for long-term oral health.

Conclusion

Implant-supported prostheses and orthodontic space closure are both useful but situation-specific approaches. To maximise outcomes, interdisciplinary cooperation and careful patient selection are crucial. Long-term success is ensured by adjusting treatment to meet biological, functional, and aesthetic needs.

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