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Corrective Techniques for Mal-positioned Dental Implants — A Review

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Abstract

Mal-positioned dental implants present significant functional, esthetic, and biomechanical challenges, arising from inaccuracies in three-dimensional positioning related to spatial, angular, and rotational deviations. These errors may result from anatomical limitations, planning deficiencies, surgical inexperience, or inadequate use of digital guidance, leading to complications such as peri-implantitis, soft-tissue recession, prosthetic misfit, and compromised load distribution. This review summarizes the classification of implant mal-positions and critically evaluates available corrective strategies, including prosthetic compensation, implantoplasty, ridge and soft-tissue augmentation, segmental osteotomy, and definitive explantation with re-implantation. Additionally, the role of digital workflows AI-enhanced diagnostics, CBCT-based planning, dynamic navigation, and 3D-printed guides—is highlighted for both prevention and correction. Treatment selection depends on the severity and clinical impact of the malposition, with multidisciplinary planning essential for predictable functional and esthetic outcomes. A comprehensive understanding of these corrective options supports safer, more precise, and patient-centered implant rehabilitation.

Keywords: Dental implant malposition, Corrective techniques, Prosthetic compensation, Implant removal, Digital implant planning

Introduction

Dental implant malposition refers to the inaccurate three-dimensional placement of an implant fixture in relation to the intended prosthetic position, adjacent structures, and surrounding anatomy, and is commonly classified by deviations in apico-coronal (vertical), mesio-distal (arch-related horizontal), bucco-lingual (transverse horizontal), angular, and rotational orientations.[1] Apico-coronal discrepancies occur when implants are placed too shallow or too deep, compromising esthetics and emergence profiles, while mesio-distal errors create spacing or contact problems with adjacent teeth or implants; bucco-lingual malpositions often lead to cortical plate perforation or disharmonious soft-tissue contours.[2] Angular inaccuracies disrupt load distribution and prosthetic alignment, and rotational errors hinder the proper seating of prosthetic components. These malpositions arise from multiple factors, including anatomical limitations such as insufficient bone volume or unfavorable ridge morphology; planning-related errors like inadequate radiographic or virtual assessment; improper fabrication or use of surgical guides; surgical inexperience leading to deviation during osteotomy preparation; and patient-related challenges involving limited access, anatomical variation, or healing unpredictability.[3] The consequences can be significant, encompassing anterior esthetic failures, increased susceptibility to plaque accumulation and peri-implantitis, prosthetic complications involving misfit, screw loosening, or biomechanical overload, as well as functional and phonetic disturbances due to improper implant emergence and occlusal relationships.[4] Given these wide-ranging clinical implications, timely and appropriate correction of malpositioned implants is essential to preserving peri-implant health, ensuring long-term implant success, and achieving predictable functional and esthetic outcomes, highlighting the critical role of meticulous pre-surgical planning, precise guided placement, and evidence-based corrective strategies when deviations occur.[5]

Classification of Implant Malposition

Implant malposition can be comprehensively understood through a multidimensional classification system encompassing spatial, angular, rotational, and combined three-dimensional deviations. Spatial malpositions include buccal–lingual errors, where the implant is placed excessively toward the cheek or tongue/palatal side, often resulting in cortical plate perforation or an unfavorable emergence profile; mesial–distal discrepancies, in which implants are positioned too close to or too far from adjacent teeth or fixtures, leading to contact issues or undesirable spacing; and vertical depth errors, where apico-coronal misplacement produces implants that are too shallow or too deep within the alveolus, compromising soft-tissue harmony, crown length, and overall esthetics.[6] Angular malpositions arise from improper tilting of the implant in the buccal–lingual or labial–palatal dimension, disrupting biomechanical force distribution and complicating prosthetic alignment, while rotational malpositions involve incorrect twisting of the implant around its long axis, impairing the fit and orientation of internal connection components and multi-unit prostheses.[7] When these deviations occur simultaneously, they form complex three-dimensional malpositions that significantly affect prosthetic predictability, esthetics, and implant biomechanics.[8] Accurate categorization of these errors requires detailed imaging particularly CBCT and digital planning systems, which allow clinicians to quantify deviations and develop individualized corrective strategies ranging from prosthetic compensation and soft-/hard-tissue interventions to advanced surgical approaches such as segmental osteotomy or implant removal with guided re-implantation, ultimately aiding in prevention and improved treatment outcomes.[3,4]

Corrective Techniques

Prosthetic-Based Corrections

Prosthetic approaches offer a conservative means to manage minor to moderate implant malpositions by optimizing restorative alignment without resorting to additional surgery. Angulated abutments, typically ranging from 15° to 35°, enable correction of moderate implant axis deviations, improving crown positioning and esthetics. Custom CAD/CAM abutments further enhance corrective potential by allowing digitally designed, patient-specific solutions that address angular and rotational discrepancies while refining emergence profiles, occlusion, and soft-tissue support.[9] In multi-implant or full-arch rehabilitations, multi-unit abutments facilitate correction of implant angulation and ensure a common

prosthetic platform, thereby improving the fit and predictability of bridges or hybrid restorations. Telescopic crowns offer another valuable option for implants with unfavorable trajectories by employing primary and secondary crown components to enhance alignment, retention, and prosthetic stability, particularly in complex cases. Hybrid prostheses, combining elements of fixed and removable designs, can compensate for more pronounced malpositions through customized frameworks or resilient connectors that restore esthetics and function even when implant axes are misaligned.[10] Despite these advantages, prosthetic compensation has limitations: altered load direction can compromise biomechanics and increase stress on peri-implant bone and the implant–abutment interface; esthetic outcomes may remain suboptimal, especially in the anterior region where soft-tissue harmony is critical; and intricate prosthetic designs can hinder effective oral hygiene, elevating the risk of plaque accumulation, peri-implant mucositis, and peri-implantitis.[11]

Surgical Recontouring and Implantoplasty

Surgical recontouring and implantoplasty are conservative surgical approaches aimed at managing minor implant malpositions, particularly when small areas of implant exposure or buccal plate perforation contribute to soft-tissue irritation or plaque accumulation. Implantoplasty involves mechanically smoothing or removing exposed or sharp implant threads—typically with diamond or carbide rotary burs to minimize surface roughness, reduce bacterial retention, and promote better soft-tissue adaptation.[12] These techniques are indicated in situations where limited thread exposure results from thin buccal bone or localized peri-implant bone loss, when buccal plate perforation during placement creates sharp prominences, when implant removal would constitute unnecessary overtreatment, or when prosthetic or soft-tissue modifications alone fail to resolve localized inflammation or irritation.[13] However, several risks and limitations accompany this procedure: overheating during mechanical instrumentation may compromise adjacent bone and soft tissues unless continuous irrigation and controlled technique are employed; mechanical abrasion can release titanium particles or metal ions that may provoke local inflammatory responses, though the broader clinical relevance remains uncertain; and the conversion of a rough implant surface to a smoother one can influence osseointegration potential and alter bacterial colonization patterns. Additionally, implantoplasty is suitable only for minor surface exposures and cannot address significant spatial or angular malpositions.[14]

Alveolar Ridge and Soft Tissue Augmentation for Malpositioned Implants

Alveolar ridge and soft tissue augmentation techniques play a critical role in correcting or compensating for implant malpositions associated with hard- and soft-tissue deficiencies. Guided Bone Regeneration (GBR) is frequently employed to rebuild deficient alveolar ridges where bone resorption or improper implant placement has compromised ridge thickness or height, particularly in the anterior maxilla where thin buccal bone predisposes implants to exposure and esthetic complications.[15] Using barrier membranes and bone grafts, GBR restores the necessary volume to support prosthetically ideal positioning and can be performed either before implant placement or concurrently, depending on defect dimensions. Soft-tissue deficiencies, such as a thin biotype or mucosal recession exacerbated by implant malposition, are commonly managed with connective tissue grafting, which enhances peri-implant soft-tissue thickness, improves the emergence profile, and contributes to superior esthetic outcomes.[16] In situations where complete surgical correction is impractical, a combination of limited augmentation and prosthetic camouflaging utilizing custom abutments and tailored crown design can offer partial esthetic correction.[17] For more pronounced malpositions, segmental or repositioning osteotomy provides a more advanced surgical option, allowing the osseointegrated implant and surrounding bone to be mobilized and repositioned en bloc into a prosthetically favorable position. This technique relies on precise piezoelectric osteotomies and rigid fixation but is technically demanding, associated with greater postoperative morbidity, and reserved for carefully selected cases where prosthetic adjustments or minor surgeries cannot achieve functional or esthetic rehabilitation.[18]

Explantation and Re-implantation of Malpositioned Dental Implants

Explantation and subsequent re-implantation represent definitive corrective strategies for severely malpositioned implants when prosthetic or minor surgical options cannot achieve functional or esthetic rehabilitation. Reverse-torque removal is the preferred first-line method, using a counter-torque ratchet system that engages the implant's internal connection and applies controlled counterclockwise force to unscrew the fixture with minimal trauma.[19] This approach preserves surrounding bone and soft tissue and demonstrates high success rates, often exceeding 95%, making it suitable when the implant is intact and accessible. When reverse torque removal is unsuccessful such as in cases of implant fracture or extremely dense osseointegration trephine-based removal becomes necessary.[20] Trephine burs cut a cylindrical channel around the implant, allowing its retrieval but at the cost of greater bone removal, requiring precise planning to maintain sufficient residual bone for future implant placement. Explantation is indicated for severe malpositions that compromise esthetics, biomechanics, or prosthetic feasibility; implant fractures; persistent peri-implant infections; or failed implants unresponsive to conservative management.[21] Re-implantation may be performed immediately if removal is atraumatic, infection is controlled, and adequate bone volume remains, offering the advantage of maintaining ridge dimensions and reducing overall treatment duration. In contrast, delayed placement is preferred when significant hard- or soft-tissue regeneration is required, or when infection necessitates a healing interval.[19] Regardless of timing, ridge preservation or Guided Bone Regeneration (GBR) following implant removal is strongly recommended to prevent alveolar collapse and ensure optimal bone volume for future implant support. Together, these protocols allow predictable correction of severe malpositions while maintaining long-term implant and prosthetic success.[22]

Digital and Guided Approaches for Preventing and Correcting Implant Malposition

Digital and guided technologies have significantly transformed both the prevention and correction of implant malposition by integrating AI-driven diagnostics with advanced imaging and precision-guided surgical tools. AI-enhanced CBCT planning improves the accuracy and efficiency of anatomical landmark detection such as nerves, sinus boundaries, and cortical plate contours while also enhancing image clarity and 3D visualization of bone and soft tissue.[23] This reduces human error in interpretation and enables highly precise virtual planning, allowing clinicians to anticipate anatomical limitations and avoid placement errors during implant surgery or revision. Dynamic navigation systems further elevate surgical precision by providing real-time tracking of drill position relative to the preoperative plan, helping surgeons maintain ideal implant trajectories even in complex revision cases with limited bone or challenging anatomy. These systems minimize deviations, preserve vital structures, and reduce surgical invasiveness.[24] Additionally, 3D-printed corrective surgical guides generated from digital planning data provide patient-specific templates for accurate osteotomies and implant repositioning, offering high reproducibility, reduced operative time, and improved clinical outcomes. Collectively, these technologies enhance surgical accuracy, lower complication rates, and accelerate patient recovery, while AI-driven diagnostic tools enable early detection of malpositions and timely intervention.[25]

Conclusion

In managing malpositioned dental implants, no single corrective technique is universally ideal, as treatment must be tailored to the severity, location, and clinical implications of the error. Minor deviations can often be effectively addressed through prosthetic modifications or limited soft- and hard-tissue augmentation, while moderate malpositions typically demand a combination of prosthetic, surgical, and digital strategies to restore functional and esthetic harmony. Severe positional errors, or those associated with significant complications, frequently necessitate explantation and carefully planned re-implantation to achieve predictable long-term success. Across all levels of correction, digital planning supported by CBCT, AI-enhanced diagnostics, dynamic navigation, and 3D-guided workflows remains essential for accurate assessment, precise execution, and the prevention of future malpositions. Ultimately, optimal outcomes depend on multidisciplinary decision-making, integrating surgical, prosthetic, radiologic, and digital expertise to deliver individualized, evidence-based solutions.

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