Hidden pitfalls: Understanding errors and complications in periodontal and implant therapy (Review)

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Abstract. Periodontal and implant therapies have undergone notable advancements in recent years, equipping clinicians with a diverse array of techniques and biomaterials to address both functional and aesthetic oral conditions. However, these advancements involve a spectrum of potential complications and errors that can affect treatment efficacy, patient satisfaction and long-term outcomes. Complications can occur at any stage, from initial diagnosis and treatment planning to the intraoperative and post-operative phases, due to factors such as inadequate case selection, anatomical challenges, procedural errors, or poor maintenance. The present narrative review provides a comprehensive and structured overview of the errors and complications associated with various aspects of periodontal and implant therapy. By understanding these issues, clinicians can better understand and prevent adverse outcomes, optimize patient care, and enhance the overall quality of periodontal and implant treatments.

Contents

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1. Introduction

Periodontology and implantology represent dynamic and evolving disciplines within clinical dentistry, marked by continuous innovations in diagnostic methodologies, biomaterials and surgical techniques (1). The advent of minimally invasive procedures, regenerative therapies and computer-guided implantology has revolutionized patient care, enabling clinicians to achieve functional and aesthetic rehabilitation with increasing predictability and precision (2,3).

However, these advances have led to a parallel increase in clinical complexity and the potential for procedural errors and biological complications. Treatment-related mishaps may arise at any stage, from initial diagnosis and treatment planning to intraoperative execution and long-term maintenance. Factors contributing to such complications include inadequate case selection, an incomplete understanding of anatomical intricacies, surgical inexperience and patient-specific considerations, such as systemic health, compliance and oral hygiene practices (4,5).

While some complications are minor and self-limiting, others can be severe, resulting in delayed healing, graft or implant failure, aesthetic dissatisfaction, or irreversible damage to surrounding tissues. Notably, a number of these adverse outcomes are preventable through comprehensive treatment planning, adherence to evidence-based protocols and continuous clinical vigilance (6,7).

The literature on periodontal and implant complications is expanding; however, a large amount of this research remains fragmented, anecdotal or lacking in standardized

classification (1,3). There remains a pressing need to consolidate current knowledge and identify recurring patterns of clinical error to foster improved protocols and training.

The present review aimed to provide a structured and in-depth exploration of the errors and complications encountered in both periodontal and implant therapy. By dissecting the multifactorial causes, highlighting diagnostic pitfalls and outlining contemporary management strategies, the present review aimed to equip clinicians with the insights necessary to mitigate risks and refine their practice. A proactive, prevention-driven approach is paramount, not only to preserve hard-won clinical outcomes, but also to uphold the highest standards of patient care in an increasingly demanding therapeutic landscape (8).

Successful outcomes in periodontal and implant therapy are highly dependent on appropriate patient and site selection. Several systemic, local, anatomical and patient-related factors need to be evaluated before deciding on the treatment plan. A balanced consideration of these determinants allows clinicians to distinguish between favorable and unfavorable cases. A summary of the essential aspects of good vs. poor case selection is provided in Table I.

2. Treatment errors and complications in non-surgical periodontal therapy

Non-surgical periodontal therapy (NSPT), particularly scaling and root planing (SRP), is the foundation of periodontal disease management. Although considered conservative and minimally invasive, these procedures are not free of complications, particularly when performed without proper technique, careful instrument selection or sufficient clinical awareness (9,10). One of the most frequent complications is trauma to the soft tissues, which may occur due to excessive lateral pressure, incorrect instrument angulation, or use of dull curettes. Similarly, improper handling of ultrasonic scalers without adequate irrigation can generate excess heat, jeopardizing pulpal health and adjacent periodontal tissues (11). Hard tissue complications also arise from aggressive root planing, which may strip away vital cementum or dentin, thereby reducing the regenerative potential of the root surface and even damaging restorative margins. Misuse of air-polishing devices can additionally cause epithelial abrasions and, in rare cases, subcutaneous emphysema (10). Common sequelae include dentinal hypersensitivity due to exposed tubules, temporary increases in tooth mobility in patients with advanced bone loss, and instrument fractures within periodontal pockets, which occasionally require surgical retrieval (1,10).

Another well-recognized limitation of NSPT is the incomplete removal of calculus and biofilm, particularly in deep periodontal pockets (>6 mm), furcations and root concavities. Despite modern powered instrumentation, residual deposits frequently persist. This challenge can be reduced by combining hand and ultrasonic instruments, using slim ultrasonic tips in narrow or deep sites, prescribing adjunctive antimicrobials such as amoxicillin with metronidazole in advanced or aggressive cases, and re-evaluating sites with unresolved inflammation to determine the need for surgical access. Over-instrumentation should also be avoided, since endotoxins are weakly bound to root surfaces and minimal debridement is usually sufficient. Post-treatment hypersensitivity can be managed with topical desensitizing agents and patient reassurance (10.11).

Discomfort during SRP may compromise compliance; therefore, the judicious use of local anaesthesia, quadrant-wise or full-mouth protocols and personalized oral hygiene instruction can improve patient cooperation. Adjunctive treatments, such as lasers, photodynamic therapy, or antiseptic irrigants have exhibited only limited or short-term benefits and should be considered secondary to thorough debridement, with patients clearly informed of their restricted role. Likewise, systemic antimicrobials, though beneficial in selected advanced cases, carry risks of resistance, drug interactions and adverse events, and should be prescribed only with strict clinical justification (8,9,11). Clinical decision-making must also respect the principle of 'critical probing depth': SRP is most effective at sites with probing depths >2.9 mm, whereas flap surgery provides superior results in pockets >5.4 mm (11).

Evidence from long-term studies emphasizes that NSPT in advanced disease may present further risks (12). For instance, almost one-third of patients treated with SRP experience disease recurrence within 3 years, compared with approximately half that proportion following surgical access therapy. Residual deep pockets >6 mm function as high-risk sites for biofilm persistence, facilitating recurrent breakdown and eventual tooth loss. Both surgical and non-surgical approaches have also been shown to cause attachment loss in shallow sites (≤3 mm), underscoring the iatrogenic risks of unnecessary instrumentation. A further error involves undervaluing supportive periodontal therapy; although the average annual attachment loss in well-maintained SRP and surgical patients is only 0.07-0.1 mm, individuals with poor recall compliance or untreated residual deep sites are much more likely to experience recurrent disease. Therefore, inadequate maintenance, incomplete instrumentation in deep lesions and failure to detect residual 'loser sites' represent key clinical errors (6,12). To prevent these outcomes, clinicians should recognize that surgical access often yields more stable long-term results in advanced cases, enforce rigorous supportive care, and customize treatment strategies according to probing depth, anatomical complexity and patient susceptibility, thereby optimizing safety and the predictability of outcomes (12).

3. Treatment errors and complications in flap surgeries

Poor case selection, surgical technique flaws and anatomical difficulties are frequently the causes of errors and complications in periodontal and implant therapy. An example of how intraoperative mistakes, such as a poorly designed incision or overharvesting >7 mm from the greater palatine foramen, can result in major complications, such as arterial damage, excessive bleeding, or tissue necrosis, is the palatal donor site, which is frequently used for harvesting connective tissue and free gingival grafts. Inadequate flap tension or graft immobilization during periodontal operations can result in delayed healing or graft failure. Similarly, flap necrosis, soft tissue abnormalities, or reduced function and appearance may arise from inadequate flap reflection, severe tissue damage, or incorrect implant angulation in implant therapy (13).

In such situations, the risk of infection, graft shrinkage, or colour mismatch is further increased by subpar post-operative care. Thorough anatomical evaluation, accurate surgical

Table I. Case selection criteria.

Aspect	Good case selection	Bad case selection
Systemic health	Medically fit patients or those with well-controlled conditions (e.g., diabetes, hypertension).	Uncontrolled systemic diseases (e.g., diabetes, bleeding disorders, recent cardiac events, patients on chemotherapy, radiotherapy, or IV bisphosphonates).
Oral hygiene and motivation	Consistently low plaque levels, compliance with oral hygiene instructions, and willingness to attend maintenance visits.	Poor oral hygiene, persistent plaque/calculus, and lack of cooperation with maintenance therapy.
Periodontal defects	Well-contained infrabony pockets, class I furcations, and moderate gingival recessions that are surgically manageable.	Non-contained vertical bone loss, class III furcations, or teeth with hopeless prognosis and advanced mobility.
Gingival/tissue factors	Thick gingival biotype, sufficient keratinized gingiva, stable soft tissue conditions.	Thin biotype, minimal keratinized tissue, high risk of gingival recession and poor flap stability.
Anatomical considerations	Manageable anatomy; no severe fenestrations, minimal mandibular tori or tuberosities, adequate vestibular depth for flap reflection.	Unfavourable features: prominent external oblique ridge, high genial tubercle, thin mucosa over mandibular tori, or pronounced undercuts risking perforation/bleeding.
Bone factors (implants)	Adequate ridge dimensions (≥6-7 mm width and ≥8 mm height), favourable bone density (type II-III).	Severe ridge atrophy, knife-edge ridges, poor bone density, extreme sinus pneumatization with <4 mm residual bone.
Anatomical safety	Safe distances from vital structures; inferior alveolar nerve, mental foramen, incisive canal, sublingual/submental arteries; sinus anatomy favourable or correctable.	Unclear nerve location, large anterior loop/incisive canal, high-risk sinus anatomy, or proximity to critical structures.
Radiographic planning	CBCT or OPG used to map out implant site and confirm safety margins.	Inadequate imaging or proceeding without precise radiographic assessment.
Patient factors	Motivated individuals with realistic aesthetic and functional expectations, willing to invest in long-term care.	Heavy smokers, parafunctional habits (e.g., bruxism) without protective therapy, non-compliant with maintenance, or unrealistic expectations.

CBCT, cone-beam computed tomography; OPG, orthopantomogram.

planning, cautious execution and attentive post-operative monitoring are necessary for prevention. To minimize problems and guarantee positive results, clinician experience and adherence to best procedures are essential (13).

4. Treatment errors and complications in regenerative periodontal surgery

Regenerative periodontal procedures involving the use of membranes and bone grafts are among the most complex and biologically demanding interventions in periodontology. These procedures aim to restore lost periodontal structures through the regeneration of bone and soft tissue. However, the technical and biological complexity of these surgeries increases the potential for complications. One of the most frequent errors is poor flap design, which can result in excessive tension on the surgical site and prevent optimal passive closure. This failure to achieve proper closure can lead to premature exposure of the membrane, allowing bacteria to colonize and compromise the regenerative process (14).

Membrane exposure is a critical complication in regenerative surgery, as it greatly hampers the healing process and reduces the regenerative potential of the surgical site. This exposure can lead to infection, graft displacement, fibrous encapsulation and delayed healing, all of which diminish the effectiveness of the regenerative procedure. Inadequate space maintenance is another common error, often resulting in graft collapse or resorption, further complicating healing (3,15).

The selection of biomaterials is crucial to the success of regenerative procedures. Using materials that are not biocompatible or clinically proven can result in material allergy, graft failure and poor clinical outcomes. Additionally, patient factors, such as smoking, diabetes and poor compliance with post-operative care can markedly increase the risk of developing complications. Smokers are at an increased risk of delayed healing due to a reduced blood supply and compromised immune function. Diabetic patients may experience impaired wound healing and an increased risk of infection due to poor metabolic control (3).

To minimize complications and improve success rates, clinicians need to adhere to strict case selection criteria and be sure that the materials used are supported by robust clinical evidence of efficacy and biocompatibility. Moreover, comprehensive patient education regarding post-operative care, including smoking cessation and the management of comorbid conditions, is essential for optimizing surgical outcomes. Regular follow-up visits are also critical for monitoring healing and addressing any potential issues promptly (16-19).

5. Treatment errors and complications in root coverage therapy

Root coverage procedures, such as coronally advanced flaps and connective tissue grafts, are frequently employed to manage gingival recession defects for both functional and aesthetic purposes. While these techniques have high success rates, they remain inherently technique sensitive and prone to various clinical errors that may compromise outcomes (5,20-22).

Diagnostic inaccuracies are among the earliest pitfalls in root coverage therapy. Mistaking altered passive eruption or gingival overgrowth for true recession can lead to misguided treatment decisions. Moreover, neglecting to assess key risk factors, such as tobacco use, traumatic tooth brushing habits, or an insufficient zone of keratinized mucosa, can markedly reduce the predictability of root coverage procedures (23).

Intraoperative complications often stem from poor flap design or execution. Inadvertent flap perforation, inadequate thickness, or improperly released incisions may jeopardize the vascular supply to the grafted area. Donor site morbidity, particularly when harvesting from the palatal region, may present as immediate or delayed haemorrhage, hematoma, discomfort, or tissue necrosis if anatomical landmarks are not used (23,24).

Post-operative healing may be complicated by graft sloughing, partial or complete flap necrosis, infection, or excessive scarring, particularly in cases of excessive tissue tension or compromised patient compliance. Inadequate haemostasis, flawed suturing, or premature mechanical trauma (e.g., from brushing or mastication) may further disrupt the healing process and aesthetic integration (25).

Optimal outcomes depend on a combination of factors: Precise anatomical assessment, atraumatic surgical technique, stable graft immobilization and meticulous post-operative care. Patient education, particularly in maintaining hygiene without disrupting the surgical site, plays an equally critical role in ensuring long-term success. A delicate balance between surgical finesse and biological principles underpins the successful execution of root coverage procedures (26).

6. Treatment errors and complications in ridge augmentation

Ridge augmentation procedures, such as guided bone regeneration, are vital for creating sufficient bone volume for implant placement. These procedures often involve the use of autogenous or xenograft materials, which are typically covered by barrier membranes to prevent soft tissue invasion. However, one of the most common complications associated with ridge augmentations is membrane exposure, which can occur due to insufficient soft tissue thickness, improper flap design or premature trauma to the area (27).

Other complications include wound dehiscence, infection, graft resorption and failure of the graft to integrate properly with the host bone. Procedural errors, such as overfilling the defect with insufficient stabilization of the graft or inadequate space maintenance, contribute to compromised outcomes and a greater risk of treatment failure (17).

In order to reduce the risk of such complications, meticulous planning is paramount. Pre-operative imaging, such as cone-beam computed tomography (CBCT), allows for precise defect evaluation and optimal graft material selection. Tension-free flap advancement and patient-specific graft selection tailored to individual anatomical needs can enhance the success of the procedure. Post-operative care, including clear instructions on diet and hygiene and avoiding trauma, is equally crucial in promoting healing and ensuring favourable outcomes (17).

7. Wound healing dynamics, morbidity and complications of palatal soft tissue harvesting

Owing to the abundant keratinized tissue and advantageous regeneration qualities, the palatal donor site is frequently employed for harvesting connective tissue grafts and free gingival grafts in mucogingival procedures. However, there are a number of vascular and anatomical issues at this location that could cause issues. As the palatal mucosa is extremely sensitive, post-operative pain and discomfort are typical, particularly when large or thick grafts are harvested. This can affect patient comfort and recovery (23,28). Significant bleeding or hematoma formation can be caused by intraoperative issues, such as unintentional injury to the larger palatine artery, which calls for prompt medical attention. Additionally, if the surgical site is not sufficiently protected during the early healing phase, delayed bleeding or the formation of a liver clot may occur within 48 h (23,29).

A thick layer of epithelial tissue at the donor site may further impede healing, causing prolonged discomfort; improper incision design can compromise the blood supply, resulting in tissue necrosis or sloughing, complicating healing and increasing morbidity; delayed healing, colour mismatch, graft shrinkage and unsatisfactory aesthetic outcomes; in certain cases, this can also result in inadequate vascularization or poor graft immobilization, which can lead to graft failure. To reduce these risks, clinicians need to carefully plan the dimensions of the graft, avoid harvesting >7 mm from the greater palatine foramen and ensuring tension-free suturing; effective post-operative care, including the use of palatal stents, analgesics, cold packs and close monitoring, is essential for promoting healing and minimizing discomfort (3,22,29,30).

8. Treatment errors and complications in implant positioning in the aesthetic zone and posterior region

Aesthetic zone. Successful implant placement in the anterior maxilla requires precise three-dimensional alignment within the prosthetic envelope. Even minor deviations in depth or angulation can compromise the harmony of the gingival margin and papillary architecture, leading to aesthetic disharmony that patients readily perceive (31). Errors usually arise

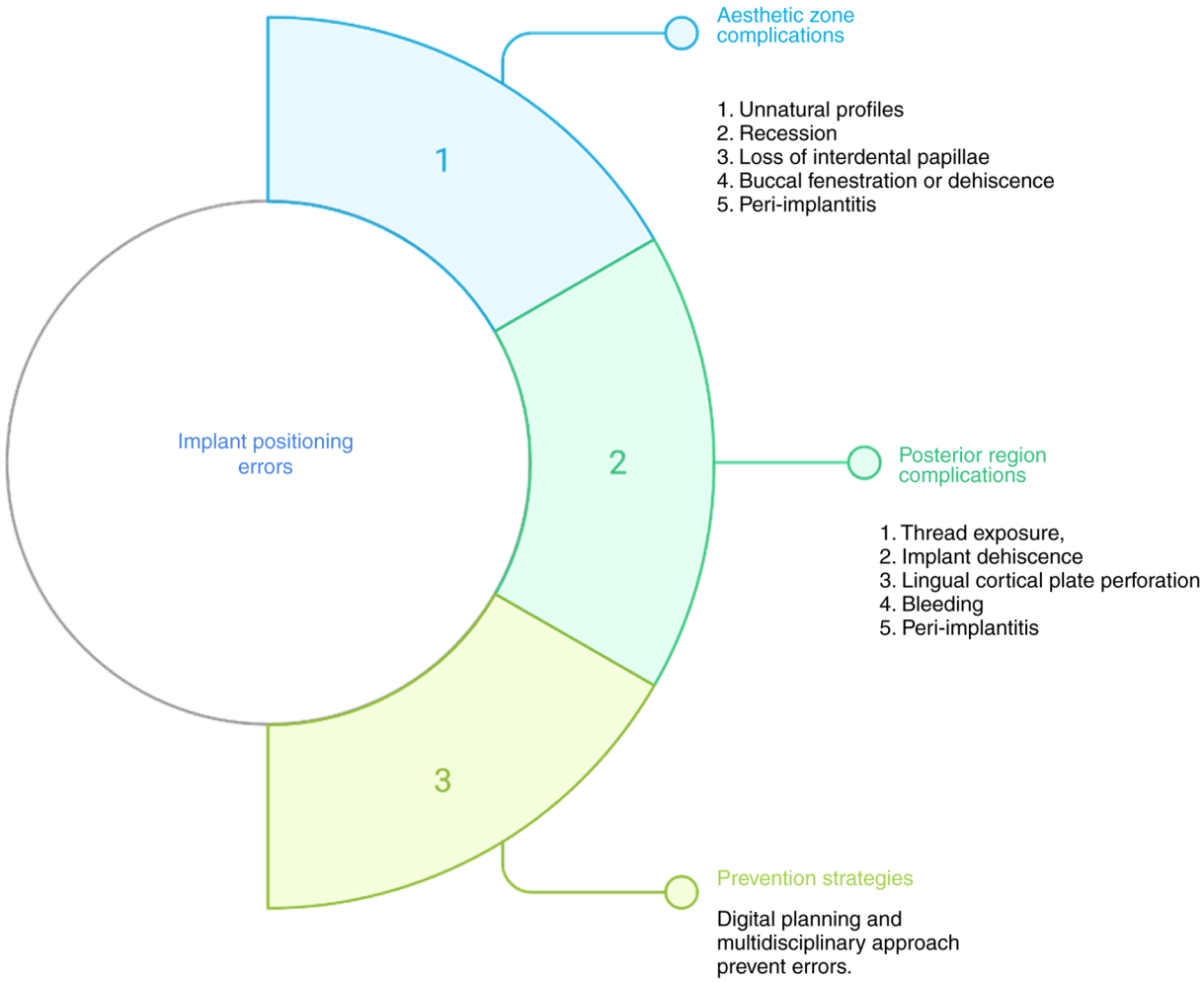

Figure 1. Schematic diagram of treatment errors and complications in implant positioning in the anterior and posterior zone.

from the inadequate use of prosthetically driven planning tools or failure to respect the underlying bone anatomy and soft-tissue biotype. Restorative challenges, such as compromised emergence profiles may necessitate additional grafting or prosthetic modifications. Incorporating CBCT-based planning, surgical templates and coordinated treatment with restorative specialists helps safeguard against these aesthetic failures (32-34).

Posterior region. Implant placement in posterior sites is complicated by reduced visibility and the proximity of vital anatomical structures. In the maxilla, the insufficient evaluation of residual bone height or sinus morphology may result in intraoperative mishaps and long-term sinus complications. In the mandible, the underestimation of lingual concavity depth or bone thickness can increase the risk of perforation and vascular injury. Beyond surgical risks, limited interarch space and dense bone quality can complicate prosthetic alignment and osseointegration. Reliance on advanced imaging, meticulous assessment of anatomic landmarks, and staged augmentation procedures are critical strategies to reduce errors in these challenging regions (6,35,36).

A schematic diagram of the treatment errors and complications in implant positioning in the anterior and posterior zone is presented in Fig. 1.

9. Treatment errors and complications in peri-implant soft tissue management

In healthy conditions, the peri-implant site is characterized by the absence of erythema, and the absence of bleeding on probing, swelling and suppuration. Peri-implantitis is a plaque-associated pathological condition that occurs in tissues around dental implants and is characterized by inflammation in the peri-implant mucosa and subsequent progressive loss of supporting bone. Histologically, peri-implantitis manifests as apically extending lesions beyond the junctional epithelium, with dense infiltrates rich in neutrophils, macrophages and plasma cells, reflecting a more advanced and destructive state than peri-implant mucositis does. Clinically, peri-implantitis is characterized by mucosal recession, increased probing depths, bleeding on probing and/or suppuration and progressive radiographic bone loss, which is frequently associated with plaque accumulation and inadequate maintenance (19,37). The health and stability of peri-implant soft tissues are critical to the long-term success of dental implants. Complications, such as mucosal recession, insufficient attached gingiva and inadequate vestibular depth can arise from poor flap management, improper soft tissue handling, or failure to perform soft tissue augmentation procedures when indicated. Thin biotypes are particularly prone to gingival fenestrations, whereas

Table II. Strategies for the prevention and management of errors and complications in periodontal and implant therapy.

Section/procedure	Common errors and complications	Preventive and management strategies
1. Non-surgical periodontal therapy (SRP/NSPT)	Soft tissue trauma, root surface over-instrumentation, dentinal hypersensitivity, incomplete calculus removal in deep pockets, instrument fracture, subcutaneous emphysema, discomfort, poor compliance.	Use proper instrument angulation and sharp curettes; ensure adequate irrigation with ultrasonics; combine hand and powered instruments in deep/narrow pockets; avoid aggressive root planing; prescribe adjunctive antimicrobials (e.g., amoxicillin + metronidazole) only in advanced cases; use local anaesthesia for comfort; re-evaluate unresolved pockets for surgical access; manage hypersensitivity with desensitizing agents; emphasize supportive periodontal therapy (SPT) with strict recall.
2. Flap surgeries	Poor incision design, overharvesting palatal tissue, flap necrosis, excessive bleeding, graft mobility, tissue shrinkage, infection, compromised aesthetics.	Careful case selection; respect anatomical landmarks (avoid >7 mm from greater palatine foramen); achieve tension-free flap closure; ensure graft immobilization; atraumatic reflection; meticulous suturing; good post-operative instructions; clinician training and surgical experience.
3. Regenerative periodontal surgery	Flap tension, membrane exposure, infection, graft collapse/resorption, allergic reactions, poor healing in smokers/diabetics.	Design tension-free flaps with primary closure; ensure space maintenance; use biocompatible, evidence-based biomaterials; control systemic conditions (diabetes); enforce smoking cessation; provide rigorous post-operative care and frequent monitoring.
4. Root coverage procedures	Misdiagnosis of recession, poor flap thickness/design, flap perforation, donor site morbidity, graft necrosis, scarring, colour mismatch.	Correct diagnosis (differentiate from altered passive eruption); evaluate risk factors (smoking, trauma, thin biotype); use atraumatic harvesting with respect to palatal landmarks; ensure adequate flap thickness and vascularity; stabilize grafts; maintain haemostasis; instruct patients on careful hygiene; ensure tension-free sutures.
5. Ridge augmentation (GBR)	Membrane exposure, wound dehiscence, infection, graft resorption, graft instability.	Perform CBCT-based pre-operative planning; select graft materials appropriately; avoid overfilling; achieve set al fixation and space maintenance; tension-free flap advancement; prescribe proper post-operative instructions to avoid trauma.
6. Palatal soft tissue harvesting	Post-operative pain, bleeding, hematoma, tissue necrosis, delayed healing, graft shrinkage, poor aesthetics.	Limit graft size and thickness; avoid harvesting too close to greater palatine foramen; design incisions preserving blood supply; use palatal stents and cold packs post-operatively; ensure meticulous haemostasis; prescribe analgesics; close monitoring for delayed bleeding or necrosis.
7. Implant placement-aesthetic zone	Incorrect 3D positioning, poor emergence profile, gingival recession, papilla loss, aesthetic failure.	Prosthetically driven planning; CBCT-based site analysis; use surgical guides/templates; coordinate with restorative specialists; assess gingival biotype and bone morphology pre-operatively.
8. Implant placement-posterior region	Limited visibility, sinus perforation, vascular injury, poor interarch space, dense bone complications.	Detailed CBCT assessment; identify sinus anatomy and mandibular landmarks; staged augmentation if inadequate bone; use careful drilling protocols; manage occlusion precisely.
9. Peri-implant soft tissue management	Mucosal recession, thin biotype complications, graft exposure, inadequate vestibular depth.	Assess soft tissue biotype early; plan augmentation when indicated; use autografts or collagen matrices; design tension-free flaps; ensure graft stabilization; educate patients on post-operative hygiene.
10. Peri-implant hard tissue management (peri-implantitis)	Bone loss, pocketing, implant failure, progression from mucositis to peri-implantitis.	Early detection and treatment of mucositis; regular maintenance visits; avoid excess cement/occlusal overload; decontaminate implant surfaces (air abrasion, laser, chemicals); use regenerative surgery in advanced cases; reinforce patient hygiene.

Table II. Continued.

Section/procedure	Common errors and complications	Preventive and management strategies
11. Maxillary sinus elevation	Schneiderian membrane perforation, sinusitis, graft migration, bleeding, oroantral communication.	Use minimally invasive techniques (e.g., piezosurgery); precise anatomical localization via CBCT; manage membrane perforation with collagen/PRF; prescribe antibiotics and decongestants; patient positioning instructions post-op.
12. Periodontal/implant therapy in medically compromised patients	Delayed healing, excessive bleeding, infection, osteonecrosis, systemic complications.	Pre-operative medical consultation and investigations (HbA1c, INR, platelet count); modify treatment protocols; use local haemostatic agents; prescribe antibiotics when indicated; minimize surgical trauma; schedule close follow-up; customize oral hygiene instructions.

SRP, scaling and root planning; NSPT, non-surgical periodontal therapy; GBR, guided bone regeneration; CBCT, cone-beam computed tomography; INR, international normalized ratio.

inadequate stabilization or improper suturing during soft tissue grafting can lead to graft exposure, infection, or loss of the graft (38).

In order to mitigate these risks, the early and thorough assessment of mucosal thickness and biotype should guide treatment planning. The use of autogenous grafts or xenogenic collagen matrices, alongside the careful timing of soft tissue augmentation, either at the time of implant placement or as a separate procedure, can significantly reduce the likelihood of complications. Ensuring proper graft stabilization and a well-designed flap that accommodates the needs of the graft are essential for the success of soft tissue management around implants (20,38).

10 Treatment errors and complications in peri-implant hard tissue management

Peri-implantitis represents one of the most formidable challenges in ensuring the long-term success of dental implants. Characterized by progressive bone loss, chronic inflammation and pocket formation, peri-implantitis compromises the structural integrity of the implant and its surrounding tissues. A multifactorial aetiology underlies this condition, with poor plaque control, cement remnants, excessive occlusal loading and a history of periodontitis contributing significantly to its onset and progression (6,19).

Early diagnosis and intervention are paramount. Failure to recognize mucositis, often the precursor to peri-implantitis, can lead to irreversible bone destruction and implant failure. Once diagnosed, effective management involves a comprehensive approach, including implant surface decontamination techniques such as air abrasion, laser therapy, or the use of chemical decontaminants. In advanced cases, surgical or regenerative treatments are required to arrest disease progression and promote tissue healing.

Prevention remains the cornerstone of successful implant therapy. Ensuring accurate implant placement, avoiding excessive occlusal stress and educating patients on optimal oral hygiene practices are essential for reducing the risk of peri-implant complications. Additionally, regular maintenance visits and early intervention in the event of tissue changes are critical for prolonging the lifespan of implants (33,34).

11. Avoiding intra- and post-operative complications in maxillary sinus elevation

Maxillary sinus elevation procedures are critical components of implantology when insufficient bone volume in the posterior maxilla is addressed. The procedure, however, is not without its complications, particularly intraoperative challenges (35). One of the most common and concerning intraoperative complications is perforation of the Schneiderian membrane. This delicate membrane plays a pivotal role in maintaining sinus integrity, and its perforation can lead to severe complications, including infection, graft migration and oroantral communication (24).

Other intraoperative challenges include the risk of developing sinusitis, haemorrhage and excessive post-operative congestion. These issues can be mitigated by adopting minimally invasive techniques, such as piezosurgery, which enables atraumatic bone cutting and preserves accurate localization of the sinus anatomy, reducing the likelihood of membrane perforation and other complications (39).

Post-operative management is equally critical. Antibiotics to prevent infection, nasal decongestants to reduce swelling and patient positioning recommendations to avoid undue pressure on the graft site are essential components of post-surgical care. In cases of significant membrane perforation, adjunctive therapies, such as collagen membranes or platelet-rich fibrin can promote membrane healing and further safeguard the success of the procedure.

12. Lack of evidence regarding errors and complications in periodontal and implant therapy

Despite the well-established nature of complications in periodontal and implant therapies, there remains a notable paucity of high-quality evidence documenting their true incidence

classification and long-term outcomes. An ample amount of the available evidence is derived from small cohort studies, case series, or anecdotal reports, which limits the ability to generalize findings or identify consistent patterns across diverse patient populations and clinical settings (5,36).

The absence of standardized definitions for complications exacerbates the difficulty in comparing outcomes across studies and clinical practices. A comprehensive and unified classification system would allow for more reliable reporting and a clearer understanding of complication rates. In order to fill these gaps, there is an urgent need for longitudinal, randomized controlled trials, as well as the establishment of national and international registries to track implant-related failures and complications over extended periods of time.

Furthermore, the development of evidence-based clinical guidelines would greatly benefit clinicians by providing clear frameworks for the prevention, early detection and management of complications. Such evidence will not only improve patient outcomes, but will also enhance training programs for future clinicians, equipping them with the tools necessary to mitigate risk and optimize treatment strategies (5).

13. Treatment errors and complications in periodontal therapy in medically compromised patients

Periodontal therapy in medically compromised patients presents unique challenges, as systemic conditions such as uncontrolled diabetes mellitus, bleeding disorders, cardiovascular diseases and immunosuppression exacerbate the risk of complications. For example, poor glycaemic control in diabetic patients markedly impairs wound healing, elevates infection rates and increases the risk of periodontal breakdown. Similarly. Patients receiving anticoagulant therapy are at an increased risk of perioperative bleeding, which can complicate surgical procedures.

Failure to adequately modify treatment protocols for these patients can lead to severe outcomes, such as delayed wound healing, wound dehiscence, osteonecrosis, or even systemic infections. A thorough pre-operative evaluation, including a comprehensive medical history, interprofessional communications with the healthcare team of the patient, and relevant laboratory investigations (such as international normalized ratio, HbA1c levels and platelet count), is essential for mitigating these risks.

Treatment strategies to reduce complications include the use of local haemostatic agents, the use of therapeutic interventions to limit stress on the patient, antibiotic prophylaxis to prevent infection, and patient-specific oral hygiene instructions. Clinicians need to balance the therapeutic benefits of periodontal intervention with the potential systemic risks, proceed with caution and adjust the treatment approach as necessary to safeguard patient health (40).

A summary of preventive and corrective measures is outlined in Table II. This table provides practical strategies to minimize errors and manage complications across different phases of periodontal and implant therapy.

14. Conclusion and future perspectives

Limitations of current evidence. Current knowledge on errors and complications in periodontal and implant therapy is constrained by weak evidence. The majority of studies are observational, with small cohorts and inconsistent outcome measures, limiting comparability and clinical translation (13,15). In implant research, variations in operator skill, surgical protocols, and patient selection further complicate interpretation. Data on long-term outcomes and rare complications remain limited. These shortcomings highlight the need for standardized definitions, uniform reporting, and well-designed prospective multi-centre trials to provide stronger guidance for prevention and management strategies.

In conclusion, although not uncommon, complications in periodontal and implant therapy can significantly affect treatment success and long-term patient outcomes. These complications often arise from a combination of anatomical limitations, operator error and systemic health factors, underscoring the need for a comprehensive and proactive approach to prevention and management. As summarized in the present review, a thorough understanding of the potential challenges, combined with careful planning and adherence to evidence protocols, is critical for minimizing complications. Emphasizing patient-specific care, precise surgical techniques and continuous professional development will allow clinicians to anticipate risks and optimize treatment strategies. Furthermore, embracing a multidisciplinary, patient-centred approach will not only enhance clinical outcomes, but will also ensure the delivery of safe, effective and personalized care. By refining these practices, clinicians can markedly improve the success rate of periodontal and implant therapies, ultimately advancing the standard of care and improving the quality of life of patients.

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Authors' contributions

VR was involved in the conception and design of the study, the compilation of data from the literature, the analysis and interpretation of data from the literature and manuscript preparation. AU was involved in the design of the study, and in the reviewing and editing of the manuscript. AS was involved in manuscript preparation, and in the reviewing and editing of the manuscript. SUN was involved in the conception and design of the study, the compilation of data from the literature, the analysis and interpretation of data from the literature, and in manuscript preparation. All authors have read and approved the final manuscript. Data authentication is not applicable.

Ethics approval and consent to participate

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Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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