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Review Article

Overcoming Implant Prosthesis Complications: Strategies for Success – A Review

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ABSTRACT:

Over the past ten years, clinical prosthodontics has undergone considerable advancements, driven by both scientific progress and the evolving demands of patients. Traditional methods for replacing a single missing tooth in prosthodontics include removable partial dentures, partial and full coverage bridges, as well as resin-bonded bridges. In recent years, dental implants have surged in popularity due to their ability to restore functionality to a level that closely resembles natural teeth, applicable to both partially and completely edentulous arches. There is a robust body of evidence supporting the use of fixed implant-supported prostheses as a dependable treatment modality for the replacement of one or more missing teeth in contemporary practice. However, as dental implants become the preferred solution for tooth replacement, various challenges associated with their use are also becoming increasingly apparent.

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INTRODUCTION

The goal of modern dentistry is to restore normal contour, function, comfort, esthetic, speech and health, regardless of atrophy, disease or injury of the stomatognathic system. Throughout history, humans have attempted to replace missing or diseased tissue with natural or synthetic substances. A dental implant is actually a replacement for the root or roots of a tooth[1].

Dental implants have become increasingly popular in recent years due to their ability to restore functions to near-normal levels in both partial and total edentulous individuals. In the dental profession, dental implants have become a viable alternative to traditional dentures and bridges[2].

An organized and systematic approach during the diagnostic stage will help to address predictably both to the functional and esthetic problems. The management of patients must integrate the knowledge of many fields of dentistry into a comprehensive treatment plan. The modern implantology approach integrates factors like dental implants' designs, materials, and surfaces with clinical and technical management. One of the most important ability of the dental practitioner is the understanding of the reactions of the peri-implant soft and bone tissues to dental implants as well as the knowledge of the subjective and objective esthetic criteria[3].

CLASSIFICATIONS:

Commonly occurring complications can be classified as follows:

According to Pjetursson et al. in 2008 (A 5-year cumulative complication rate) [4]:

i. Fracture of Prosthesis- 13.2%
ii. Peri-implantitis or peri-implant mucositis- 8.6%
iii. Loss of the screw access restoration- 8.2%
iv. Abutment screw Loosening-5.8%
v. Abutment screw Fracture- 1.5%

vi. Fracture of Implants- 0.4%

Complications can be classified as follows:

A. According to Carranza et al[5]:

1. Surgical complication
   - Haemorrhage and Hematoma
   - Neurosensory disturbances
   - Damage to adjacent teeth
   - Implant Malposition
   - Related to Sinus lift procedures
2. Biological complication
   - Inflammation
   - Peri implantitis and bone loss
   - Implant mobility
   - Dehiscence and Recession
3. Mechanical /Technical complication
   - Screw Loosing and fracture
   - Implant failure
   - Fracture of framework or restorative material
   - Cement failure
4. Esthetic/ Phonetic complication
   - Esthetic complications
   - Phonetic complications.

B. According to Misch and Wang (2008)[6]:

1. Early-Stage Complications
   - Infection
   - Edema
   - Ecchymosis
   - Bleeding
   - Flap dehiscence
2. Late-Stage Complications
   - Perforation of mucoperiosteum
   - Mandibular fractures
   - Failed Osseo integration
   - Maxillary sinusitis
   - Bony defects
   - Periapical implant lesion.

C. According to Canin[7]:

1. Intra-operative complications

i. Endosteal implants

a. Oversized osteotomy
b. Perforation of cortical plates
c. Fracture of cortical plates
d. Broken burs

ii. Sub periosteal implants

a. Loss of anaesthesia
b. Inability to make an accurate impression.
c. Antral perforation
d. Injury of the mental or infraorbital nerve

2. Short term Complications

i. Endosteal implants

a. Dehiscent wounds
b. Dehiscent implants
c. Radiolucency
d. Pterygomandibular raphe

ii Sub periosteal implants

a. Pterygomandibular raphe
b. Scar contraction
c. Post-operative infection

3. Long term complications
i Endosteal implants
a. Broken prosthetic inserts
b. Screw fracture
c. The inaccurate fit of castings
ii Sub periosteal implants
a. Bone resorption
b. Broken abutments
c. Recurrent peri-cervical granuloma.

PROSTHETIC COMPLICATIONS:

1. Complications related to immediately loaded dental implants:

A. Material failure: It should be recognized that there is a possibility of alveolar damage which may be magnified if tapered or wide platform implants are forced into dense bone without adequate osteotomy preparation. Forcing implants into underprepared sites risks the biological complications related to compromise healing or implant failure, as well as material failure of the implant.

Management: The implant surface coatings comprise titanium oxide (TiO2) coating, ceramic coating, or diamond coating. Biodegradable ceramic coating may have the best future prospects. Most dental implant materials presently used in clinics are quite biocompatible in human tissues in their specific dental application. They are usually made of titanium, titanium-aluminium-vanadium (Ti-6Al-4V), cobalt-chromium-molybdenum, and more rarely of other alloys[1&8].

Table 1: Prosthetic complication

1. Complications related to immediately loaded dental implants	2. Immediately loaded full-arch hybrid prosthesis	3. Overdentures	4. Occlusal Complications	5. Single unit prosthesis	6. Multiple Unit Prosthesis
A. Material failure B. Gingival recession, blunted papillas, incomplete regeneration C. Occlusal mismanagement D. Inadequate support, improper design, loss of retention. E. Incompletely seated prosthetic components F. Adjustment to the tissue-fitting surface of the prosthesis	A. Alveolar defects precluding optimal implant placement or primary stability B. Restorative complications relating to hybrid prosthesis (i) Provisional or component fracture (ii) Implant loss (iii) Retained impression or prosthetic materials (iv) Incompletely seated prosthetic components (v) Phonetics	A. Inadequate Crown Height Space (CHS) B. Poor Osseous Angulation (C-A) C. Non-ideal Implant Positioning D. Retention Loss Over Time E. O-Ring Failure F. Bar try in resulting in pain G. Gingival inflammation around bar H. Prosthesis with lack of soft tissue support in RP-5 I. Overdenture fractures J. Food impaction	A. Moment Loads B. Occlusal Height C. Not Utilizing Implant-Protected Occlusion D. Premature Occlusal Contacts E. Poor Emergence Profile F. Parafunctional Habits	A. Improper Crown Margin B. Abutment Not Seated C. Prostheses Fractures/Occlusal Material Fracture D. Abutment Will Not Tighten E. Improper Torqueing Technique F. Damaging Implant Body	A. Screw Tightening Sequence B. Screw Fracture

B. Gingival recession, blunted papillas, incomplete regeneration:

Complications within the esthetic zone can be caused by various errors committed before, during, or after the placement of implant. Several factors can lead to these failures replacing multiple teeth, adjacent implants could compromise the interimplant crestal bone, resulting in resorption and soft-tissue loss.

Management:

Good esthetic results and dimensionally stable tissues can be obtained when implants are immediately placed and restored in healed ridges. Sockets should be carefully evaluated and categorized. This can be done preoperatively using a CBCT to image the buccal plate or clinically using Periapical radiographs and periodontal probing measurements[1, 8&9].

C. Occlusal mismanagement:

Determining an occlusal scheme for the restoration of implants requires careful consideration. Occlusal overload is often regarded as one of the main causes of peri-implant bone loss and implant prosthesis failure because it can cause crestal bone loss, thus increasing the anaerobic sulcus depth and peri-implant disease states. It can be rightly said that occlusion is a determining factor for implant success in the long run[10].

Management:

- Elimination of premature occlusal contacts-While restoring an implant, a thin, articulating paper is used (<25 µm) for the initial implant occlusion adjustment in centric occlusion under light tapping forces.

- Provision of adequate surface area to sustain load transmitted to the prosthesis- Increased load can be compensated for by increasing the implant width; reducing crown height; ridge augmentation if necessary; increasing the number of implants; or splinting the prosthesis.
- Controlling the occlusal table width-The width of the occlusal table is directly related to the width of the implant body. The wider the occlusal table, the greater the force developed to penetrate a bolus of food. However, a restoration mimicking the occlusal anatomy of natural teeth often results in offset load (increased stress), increased risk of porcelain fracture, and difficulties in home care (due to horizontal buccolingually offset/cantilever).As a result, in the nonaesthetic regions the width of the occlusal table must be reduced in comparison to a natural tooth.
- Occlusion contact position-The ideal primary occlusal contact should reside within the diameter of the implant within the central fossa. The secondary occlusal contact should remain within 1 mm of the periphery of the implants to decrease the moment loads
- Mutually protected articulation- This implies that during excursion the posterior teeth are protected by the anterior guidance, whereas during centric occlusion the anterior teeth have only light contact and are protected by the posterior teeth. It must be kept in mind that the anterior guidance of the implant prosthesis with anterior implants should be as shallow as practicable. The steeper the anterior guidance, the greater are the anticipated forces on anterior implants. In case of a single tooth implant replacing a canine, no occlusal contact is recommended on the implant crown during excursion to the opposite side. The rationale of mutually protected occlusion is that the forces are distributed to segments of the jaws with an overall decrease in force magnitudes. It must also be kept in mind that if anterior implants must disocclude the posterior teeth, two or more implants splinted together should help dissipate lateral forces whenever possible.
- Occlusal guidelines for different clinical situations- In case of a full-arch fixed prosthesis, if the opposing arch is a complete denture, balanced occlusion is recommended. Group function or mutually protected occlusion with shallow anterior guidance is recommended when opposing natural dentition or a full-arch fixed prosthesis. In case of overdentures, bilateral balanced occlusion with lingualised occlusion should be used. If the posterior arch is rehabilitated with a fixed prosthesis, contacts should be centered over the implant body, and narrow occlusal tables, flat cusps with minimized cantilever should be employed. Guidelines for choice of reconstruction and occlusal concept when rehabilitating the edentulous mandible with oral implants have been suggested by Quirynen M et al. In case of the fully edentulous maxilla, whether the mandibular rehabilitation is done on an overdentures supported on two implants or on a mucosal-implant supported overdenture (four implants with a bar attachment), a balanced occlusal scheme (bilateral/ lingualized /monoplane) is recommended. In cases where the maxillary arch presents with Kennedy's class III and IV and implant-supported prosthesis is advised for the mandible, group function or mutually protected occlusion is recommended. Lastly, in case of the fully dentate maxilla and implant-supported prosthesis, group function or mutually protected occlusion is recommended[10&11].

D. Inadequate support, improper design loss of retention: If a provisional loosens from the supporting implants too early in the healing process or if the implant support and restoration are inadequately engineered, implant failure may occur.

Management: In full-arch immediate loading cases, the provisional restoration must be designed to manage direct occlusal forces in addition to splinting implants and limiting mobility.

E. Incompletely seated prosthetic components: In flap surgery, it is possible for ledges of bone to prevent complete abutment seating. Also, an incompletely seated abutment could become a bacterial reservoir leading to crestal bone loss and may not distribute load to the underlying implant, contributing to overloading of other implants.

Management: These instances could have been avoided by using implant manufacturer's crestal bone milling tools to clear away spicules of bone that could interfere with abutment seating. The problems could have been discovered at the time of surgery by taking Periapical radiographs immediately following abutment connection.

F. Adjustment to the tissue-fitting surface of the prosthesis: The thickness of the mucosa is difficult to assess on radiographs. As a result, the amount of contact pressure between the soft tissue and prosthesis often needs to be adjusted.

Management: It is important to resolve this issue in the provisional restoration prior to fabrication of the final restoration. Communication between the patient, restorative dentist, and the dental technician is important at this stage[1].

2. Immediately loaded full-arch hybrid prosthesis

A. Alveolar defects precluding optimal implant placement or primary stability: Typically, patients requiring full-arch hybrid restoration have significant bone loss manifesting either as generalized alveolar atrophy resulting in reduction in bone volume or as a specific alveolar defect, which might be associated with site specific bone loss.

Management: It is essential to obtain 3D radiographic imaging and complete surgical planning for immediately loaded hybrid procedures. The available alveolar structures should be evaluated for bone volume, alveolar defects, relative bone density, and ability to obtain a favourable implant distribution to optimize the "supporting zone" for the proposed prosthesis.
Early or immediate loading can be chosen if the patient is in good health and there are no risk factors present, if implant stability was achieved or a high insertion torque was measured, if no or little grafting is required at the time of placement, or if the bone volume allows for the placement of standard diameter implants. To choose early or immediate loading, all of these treatment-modifier traits must be present[1&12].
B. Restorative complications relating to hybrid prosthesis:
(i) Provisional or component fracture: Provisional restorations for hybrid cases are particularly important for the success of the procedure since the number of implants is reduced compared with cement-or screw-retained ceramic–metal design cases.
Management: The fewer the number of implants supporting the restoration, the stronger and stiffer the provisional material need to be to resist functional stresses. Three months postoperatively, the provisional has to be removed and all components were retorqued to insure implant osseointegration and abutment tightness. Patient should be under regular follow up and checked for sequence of osseointegration to prevent abutment fracture[13].
(ii) Implant loss: It most often occurs within the first few months of healing. Late failures are most likely the result of peri-implantitis and have little or no relationship to the loading protocol. Most implant failures occurred in the distal implants, male patients, poor bone quality, opposing fixed dentitions.
Management: Long-term success rates of over 90% to 95% are considered to be realistic treatment outcomes. Endosseous implant therapy can greatly improve the function and aesthetics of carefully selected partially or completely edentulous patients.The occlusal design follows the principles of periodontal prosthesis developed for restoring periodontally compromised dentition. To mitigate lateral occlusal forces provisional restorations with flat plane occlusal guards are provided[14].
(iii) Retained impression or prosthetic materials: Prosthetic materials such as acrylics, impression materials, abrasives, dust, etc. to be inadvertently introduced under or left below flaps. There is also a possibility for air from a high speed hand piece to be blown into tissue, creating soft tissue emphysema.
Management: The frequencies of these complications are unknown, but clinicians should be aware of the possibility of causing these problems. It should be checked that there should not be any remnant or residue of the impression material left in that area. The impression material should have high tear strength.
(iv) Incompletely seated prosthetic components: One common error that is made is failing to fully seat a prosthetic abutment on an implant which may occur because of several reasons. In flap surgery, it is possible for ledges of bone to prevent complete abutment seating.
Management: Once a misfit has been discovered, it should be corrected immediately as the large gap between the implant and abutment could become a bacterial reservoir leading to crestal bone loss[1].
(v) Phonetics: It has been a concern that significant immediate changes to the teeth and supporting structures would create phonetic difficulties or deteriorated speech. Patients who receive complete dentures develop distortions in articulation.
Management: These problems were not associated with vowels, but with consonants and more frequently with /s/, /t/, /d/, and /z/ sounds. It should be clear that patients should be aware that there is a risk of phonetic complaints in the long term, and that they should anticipate an adaptation period of 3–6 months following treatment[1].

3. Overdentures:
A. Inadequate crown height space (CHS): When sufficient CHS is lacking, the prosthesis fabricated over it is more prone to component fatigue and fracture and has more complications in comparison to porcelain-to-metal fixed prostheses.
Management: Dentist must take into consideration the long term results the vertical prosthetic space, the resilience of the oral mucosa, occlusal loading, and the overdenture retention and stability requirements analysed in conjunction with patient's anatomical and functional particularities[15].
B. Non-ideal implant positioning: Usually, the greatest available bone height in an edentulous mandible is located in the anterior region between the mental foraminae. Non-ideal implant positioning leads to many complications, which include hard and soft tissue complications.
Management: prevent this, when placing implants, regardless of the treatment option being executed, all five implant sites should be ideally located at the time of treatment planning and surgery[1&15].

C. Overdenture fractures: The reason may be excessive occlusal force and thin acrylic base.
Management: Ideal occlusion and even distribution of forces is mandatory. The denture base may be strengthened with the use of acrylic or meshwork. For an overdenture, always make sure there is sufficient room for attachment or bar with adequate acrylic thickness[1&15].

4. Occlusal complications:
A. Moment loads: Moment loads induce micro rotations and stress concentrations at the crest of the alveolar ridge at the implant-tissue interface, which lead inevitably to crestal bone loss.
Management: An increased crown height acts as a vertical cantilever, magnifying the stress at the implant-bone interface. Crown height is determined at the time of diagnosis and that all methods of either reducing the load or reducing the crown-implant ratio should be applied before restoration[10].
B. Occlusal height: The occlusal height serves as the moment arm for force components directed along the facio-lingual axis working or balancing occlusal contacts.
Management: Provision of adequate surface area to sustain load transmitted to the prosthesis Increased load can be compensated for by increasing the implant width; reducing crown height.
C. Not utilizing implant-protected occlusion: A poor occlusal scheme increases the magnitude of loads and intensifies mechanical stresses (and strain) to the implant system.
Management: A primary goal of an occlusal scheme is to maintain the occlusal load that has been transferred to the implant system within the physiologic and biomechanical limits of each patient.
D. Premature occlusal contacts: premature contact is most often on an inclined plane, the horizontal component of the load increases the shear crestal stresses and the overall amount of stress to the entire implant system.
Management: The elimination of premature contacts is more critical than in natural teeth because of the lack of proprioception and the implant's inability to move and dissipate the forces. All occlusal prematurities should be eliminated during maximum intercuspation and centric relation[1&10].
E. Poor emergence profile: The "emergence profile" concept was first introduced in 1977 by Stein et al. to describe tooth and crown contours from the soft tissue to the contact area interproximal. When a restoration is fabricated with an unnatural contour, Esthetics and soft tissue health will be compromised.
Management: Implants should be placed approximately 2.0 mm from a natural tooth, 3.0 mm between implants, and in the ideal buccal and lingual orientation with respect to the incisal edge and occlusal table.
F. Parafunctional habits: When an implant reconstruction is considered in a bruxing patient, a patient with significant occlusal force, or an irregular plane of occlusion, occlusal analysis is warranted. Premature and posterior contacts during mandibular excursions increase stress conditions.
Management: shorter cantilevers, proper location of the fixtures along the arch, a maximum fixture length, and night-guard protection should be prerequisites to avoid parafunctional habits or the overloading of implants in these patients[1, 3&9]

5. Single unit prosthesis:
A. Improper crown margin: Often clinicians use the prefabricated abutments with a built in flare. This is most likely 1 mm above the implant body connection, which is often near the crest of the bone, resulting in a deep subgingival margin.
Management: Implants should not proceed further than 1.5 mm below the free gingival margin even in the interproximal region. It is important to note that the implant abutment flare is often 1 mm above the implant body connection, which is often at the crest of the bone.
B. Abutment not seated: If an abutment is not fully seated within the implant, the preload placed on the screw will be insufficient. This will lead to an increased possibility of screw loosening and prosthesis mobility. An opening or microgap will lead to bacterial accumulation, which will result in soft tissue infection and irritation.
Management: When the implant is significantly subgingival, this may be difficult to determine. A radiograph should always be taken to confirm complete seating.
C. Prostheses fractures/occlusal material fracture: Occlusal material fracture is more common with implants than natural teeth because of the lack of periodontal stress relief with implants and a resultant higher impact force to the occlusal material. Porcelain, acrylic, and composite fractures may occur under excessive loads or even with a lesser load of longer duration, angulation, or frequency.
Management: A common treatment that is most widely underutilized is the use of occlusal guards. It is highly recommended to treat all patients with an occlusal guard who exhibit symptoms of parafunctional and prosthesis situations that are prone to fracture.
D. Abutment will not tighten: In some situations the abutment is tightened onto the implant; however, the abutment will move in a vertical direction. Which may lead to screw loosening or component fracture. The stability of the screw joint can be influenced by the pros-thetic implant axis. It has been shown that more screw loosening occurred with angulation-correcting implants than with straight implants.
Management: Today, implant-retained crowns are more frequently screw-retained than cemented, following current recommendations to reduce the risk of peri-mucositis and peri-implantitis via excess cement this can be easily prevented by irrigation with saline or 0.12% chlorhexidine with a small tuberculin syringe.
E. Improper torqueing technique: The use of a torque wrench improperly may lead to inadequate torque application, stripping of the hex screw head, and/or dulling of the hex driver.

Management: Thus, the torque wrench should be used with short strokes. And lastly, the torque wrench should be replaced on a regular basis and maintained in a good working condition.
F. Damaging implant body: Most implants today are fabricated from grade 5 titanium or Ti6Al4V. This metal does have the disadvantage of easily being altered or damaged. If an implant is traumatized with a handpiece and bur, or a sharp instrument, irreversible damage may be done to the implant.
Management: To prevent damage to the implant, a tissue punch bur or profiling bur should be used[1&16].

6. Multiple unit prosthesis:
A. Screw tightening: When screw tightening a multi-unit fixed implant prosthesis, a proper sequence and technique is crucial to obtain the correct torque.
Management: The torque should be applied incrementally amongst all screws so that not one screw is tightened fully. Saline may be used to lubricate the screw prior to placement of preload to maximize the accuracy of the preload.
B. Screw fracture: The etiologic factor most likely to cause screw fractures is biomechanical stress to the implant system, continuous screw loosening may eventually lead to screw fracture.
Management: the dental practitioner should understand their causes and provide a solution to minimize the risk of further screw loosening and fracture. Some of these solutions would be based on proper patient selection, proper implant site selection aimed at decreasing moment force[1&17].

CONCLUSION: Although serious complications are uncommon, dental implant placement is not free of complications, as complications may occur at any stage. Despite the high success rates and stability of dental implants, failures do occur. While surgical trauma together with bone volume and quality are generally believed to be the most important etiological factors for early implant failures, the etiology of late failures is more controversial. Early detection and treatment of early progressive bone loss around dental implants by mechanical debridement, antimicrobial therapy, and regenerative therapy are the keys for saving early failing implants[1, 6, 17&18].

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