

Review Article

Prosthodontic Management of Fractured Implant and Components: A Literature Review

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ABSTRACT:

Dental implants have revolutionized prosthodontic rehabilitation, offering reliable long-term solutions for edentulism. However, mechanical complications such as implant or component fractures, though relatively rare, present significant challenges for clinicians. Fractures can involve the implant body, abutment screw, or prosthetic components, often resulting from biomechanical overload, design flaws, material fatigue, or improper occlusion. Timely diagnosis and appropriate management are crucial to preserve peri-implant health and restore function and esthetics. Non-invasive retrieval techniques, such as screw removal kits, ultrasonic vibration, or trephining, are considered based on the fracture location and severity. In cases where removal is impractical, the fractured implant may be left in situ, and alternative implant placement considered. This literature review explores the etiology, clinical presentation, and prosthodontic strategies for managing fractured implants and associated components and also emphasizes the importance of preventive measures. Understanding fracture patterns and material behavior is key to improving long-term success rates.

KEYWORDS: Implant fracture, abutment screw fracture, implant complications, retrieval techniques, implant re-treatment.

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INTRODUCTION:

Dental implants have become a widely accepted and predictable treatment modality for the replacement of missing teeth. However, like any biomedical device, they are not devoid of complications. Among these, mechanical complications such as fractures of the implant body, abutment, or screws represent significant challenges in prosthodontic practice. A thorough understanding of the etiology, prevention, and management strategies is essential. This review aims to provide an evidence based overview of the prosthodontic management of fractured implants and associated components.

Implant Fracture: Implant fractures are defined as structural failures of the implant body or its components, compromising the integrity and function of the implant-supported prosthesis. Fractures are generally classified as:

- Implant body fractures: Complete or partial breakage of the implant fixture.
- Abutment fractures: Separation or breakage of the abutment screw or body.
- Screw fractures: Thread or head fractures, often resulting in loosening or complete detachment of the prosthesis.

Classification systems such as those proposed by Goodacre et al. further divide complications into

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Table 1: Types of Implant and Component Fractures.

Type of Fracture	Location	Common Causes	Clinical Implications
Implant Body Fracture	Within the implant fixture	Excessive occlusal load, material fatigue	Requires complete removal and replacement
Abutment Fracture	Between fixture and prosthetic	Improper fit, excessive torque	Cansometimesbe repaired
Screw Fracture	Within the abutment screw	Insufficient preload, repeated loading	Risk of implant loosening
Prosthetic Fracture	Crown or bridge on implant	Material weakness, malocclusion	Often requires prosthetic replacement

biological and mechanical, with fractures forming a subset of the mechanical type^[1].

Etiology of Implant and Component Fracture:-

Several factors contribute to implant and component fractures, which can be broadly categorized as follows:

1. Biomechanical Overload: Excessive occlusal forces from parafunctional habits (e.g., bruxism), inadequate occlusal design, and misaligned implant positioning increase the risk of stress accumulation leading to fracture^[2].

2. Material Fatigue: Cyclic loading over time can cause microcracks and eventual failure in titanium or zirconia implants, especially under tensile or bending stresses^[3].

3. Prosthetic Factors: Improper torque values, poor fit of prosthetic components, and suboptimal screw joint designs can lead to screw loosening and subsequent fracture^[4].

4. Surgical Factors: Poor bone quality, over-preparation of the implant site, and misalignment can create a biomechanically unfavorable environment contributing to implant failure^[5].

Implant body fractures are situated within the implant fixture and typically result from excessive occlusal load or material fatigue; these fractures usually require complete removal and replacement of the implant. Abutment fractures occur between the fixture and prosthetic components, often due to improper fit or excessive torque, and may sometimes be repaired depending on severity. Screw fractures are found within the abutment screw, commonly arising from insufficient preload or repeated loading, and they pose a risk of implant loosening. Lastly, prosthetic fractures affect crowns or bridges placed on implants, which can arise from material weaknesses or malocclusion and generally necessitate replacement of the prosthetic restoration. This is illustrated in Table 1.

Diagnosis of Implant Component Fractures

Fractures are diagnosed using a combination of clinical and radiographic assessments:-

A thorough clinical examination is a cornerstone of diagnosing fractured dental implants and their components. Identifying fractures, assessing implant stability, and evaluating the surrounding soft and hard tissues are essential steps in determining the appropriate treatment plan. The clinical examination of a patient with a potential fractured implant or component involves a systematic approach that includes patient history, physical inspection, functional testing, and assessment of associated tissues^[6].

Patient History and Complaint: A detailed patient history plays a crucial role in the diagnosis of fractured implants and components. The history should focus on the onset of symptoms, functional problems, and any related risk factors. Common complaints related to fractured implants and components include pain, swelling, implant mobility, and difficulty with chewing. Patients may complain of mobility or a loose prosthesis, which can be indicative of an implant fracture or screw loosening.

PHYSICAL INSPECTION:-

The dentist should look for obvious signs of damage or failure, such as visible cracks in the crown, abutment loosening, or metallic exposure.

Key aspects of the physical examination include:

- **Soft Tissue Assessment:** The condition of the surrounding mucosa should be evaluated for signs of gingival recession, inflammation, infection, or peri-implantitis. Healthy peri-implant tissues should appear pink, firm, and without signs of bleeding on probing.
- **Prosthesis and Abutment Examination:** Visual inspection of the implant crown, abutment, and

screw connection for signs of fractures, chipping, or looseness should be done. Fractured components may present as visible cracks, chips, or even complete dislodgement from the implant.

- **Occlusion Evaluation:** A thorough occlusal examination should be performed to assess the implant's function during chewing and occlusal contact. Malocclusion or excessive forces may indicate the potential for component failure.

PALPATION AND PERCUSSION:-

- **Palpation:** Gently palpate around the implant site to check for implant mobility or soft tissue inflammation. Periapical tenderness or abnormal movement in the implant can indicate implant fracture or loosening of the abutment or screw.
- **Percussion:** Percussion testing can help assess the stability of the implant. Tapping on the implant with a dental instrument may help detect implant mobility or the presence of cracks in the implant or components. A positive percussion test may suggest implant instability, which could be due to fracture or loosening.
- **Functional Testing:** involves evaluating the ability of the implant to bear load during activities such as chewing and biting. This test can help assess the implant's functional capacity and identify any abnormalities or discomfort.
- **Load Testing:** The patient is asked to bite down or chew on a test object to assess the implant's response to occlusal forces. Abnormal pain, discomfort, or implants that shift or move under pressure may indicate fractures or screw loosening.
- **Mobilization Test:** If the implant shows signs of mobility during palpation, further testing is needed to assess the degree of mobility. Mobility could be indicative of implant failure or loosening of the connection between the implant and prosthetic component.

IMPLANT STABILITY ASSESSMENT:-

Implant stability is a key factor in diagnosing fractures and failures.

- **Periotest:** A non-invasive test that measures the resonance frequency of the implant. A low resonance frequency indicates reduced stability, which may be due to implant fracture or failure.
- **Implant Mobility:** Clinical mobility is assessed by gently trying to move the implant in the buccolingual or mesiodistal direction. Perceived movement indicates implant failure, which may be caused by fracture or poor osseointegration.

- **Torque Measurement:** In cases where screws or abutments are suspected to be loose or fractured, torque measurement devices can assess the force needed to tighten or loosen the components, helping to identify the nature of the fracture.

RADIOGRAPHIC IMAGING:-

Radiographic imaging is an essential tool in diagnosing fractures, loose components, and peri-implant bone loss. Common imaging modalities include:

- **Periapical X-rays:** Conventional periapical radiographs are used to assess the status of the implant-bone interface and identify any bone loss around the implant. Fractures in the implant body or the abutment may also be visible on these images.
- **Cone Beam Computed Tomography (CBCT):** CBCT offers a 3D view of the implant site, allowing clinicians to evaluate the implant position, bone quality, and implant stability. This imaging method is particularly useful for detecting microfractures or subtle fractures that may not be visible on conventional X-rays.

Management Strategies: The management of fractured implant components is complex and depends on the type, location, and severity of the fracture. They may be non-invasive or invasive techniques.

Screw Fracture Management: Screw Fracture where the screw is unable to be retrieved at all, it leads to the removal of entire implant from the bone, making the procedure invasive

a. Retrieval of Fractured Screw:

- Conventional methods: Use of ultrasonic scalers, explorers, and screw retrieval kits.
- Modified techniques: Creating a slot in the screw and using a flathead driver to turn it out counterclockwise.
- Commercial kits: Examples include the Safe Relax system and the ITI Retrieval Kit^[7].

b. Non-Retrievable Screw: In cases where screw retrieval fails, removal of the entire implant or conversion to a cement-retained prosthesis may be required^[8].

Abutment Fracture Management: Abutment Fracture can be managed non-invasively.

Table 2: Comprehensive approach to temporary management

Temporary Management Approach	Material Used	Outcome/Benefits
Splinting	Dental resin, acrylic	Stabilizes loose or displaced components
Temporary Crowns	Acrylic, composite	Restores appearance and function temporarily
Occlusal Adjustments	No material required	Reduces stress on fractured components
Temporary Implant Replacement	Titanium, temporary crowns	Restores function, protects space

- Replace the fractured abutment if the internal implant connection is intact.
- Evaluate the need for custom abutments for better force distribution.
- Use torque control devices to ensure appropriate loading.

If the abutment fracture causes damage to the internal implant threads, removal or retrofitting of the prosthesis may be necessary^[9].

Implant Body Fracture Management: -

This represents the most severe form and often necessitates surgical intervention making it invasive.

- Non-salvageable fractures: Complete removal of the fractured implant using trephine burs.
- Salvageable cases: When only a portion of the implant is fractured, a shorter abutment can be used if the remaining portion is stable^[10].

Subsequent bone grafting and delayed implant placement may be required, depending on the defect size.

Prosthodontic Considerations for Fracture Prevention:-

The prosthodontist plays a pivotal role in the prevention of implant fractures through careful planning and execution.

The temporary management of fractured implants and components can be approached through different provisional strategies. These include splinting, which uses dental resin or acrylic materials to stabilize loose or displaced implant components; the use of temporary crowns made of acrylic or composite to restore appearance and function on a short-term basis; occlusal adjustments without additional materials to reduce stress on fractured parts; and temporary implant replacement utilizing titanium and temporary crowns to restore function and protect the implant space during healing or treatment phases. Each of these methods offers specific clinical benefits, such as stabilization, protection, and maintenance of esthetics and function while definitive treatment planning or healing occurs^[11]. This is illustrated in Table 2.

1. **Occlusal Considerations:** Occlusal considerations are important in implant therapy because implants respond differently to bite forces than natural teeth. Proper occlusion helps distribute biting forces evenly, preventing overload that can cause implant bone loss, prosthesis failure, or screw loosening. Guidelines recommend designs that minimize stress on implants, such as using mutually protected occlusion, reducing cantilever length, and selecting strong materials for prostheses. Regular occlusal checks and adjustments help maintain implant health and prevent complications, ultimately extending the implant's lifespan.

- Establishment of a mutually protected occlusion.
- Elimination of interferences in lateral or protrusive movements.
- Use of occlusal guards in bruxism patients^[12].

2. Prosthesis Design:

- Splinting of multiple implants to distribute forces evenly.
- Avoiding cantilevers or limiting their extension.
- Choosing appropriate materials for the superstructure that absorb stress (e.g., PEEK, composite resins).

3. Implant Selection and Placement:

- Use of wider or longer implants in areas with high occlusal loads.
- Placement in positions that align with the long axis of the prosthesis.
- Use of implants with internal connections to improve force distribution^[13].

4. Maintenance Protocols:

- Regular follow-up appointments to detect early signs of screw loosening or prosthesis mobility.
- Patient education on avoiding excessive forces.

Emerging Technologies and Techniques:-

Recent advancements aim to minimize mechanical complications:

Table 3: Implant removal Method.

Implant Removal Method	Indications	Advantages	Disadvantages
Rotational Instruments	Implant has fractured above the bone level	Minimally invasive, quicker procedure	May not be effective in deeply embedded implants
Trephine Bur	Implant deeply embedded in bone	Allows for removal of deeply integrated implants	Risk of bone damage, may require bone grafting
Surgical Flap Approach	In cases of implants with significant tissue damage	Provides excellent access to the implant site	More invasive, requires flap closure and post-operative care
Ultrasonic Devices	Fractured implants in hard-to-reach locations	Precise, less traumatic to surrounding tissues	High cost, requires specialized equipment

Table 4: Bone Grafting Technique.

Bone Grafting Technique	Indications	Advantages	Disadvantages
Autografts	Significant bone loss, optimal biological compatibility	No risk of disease transmission, excellent healing	Limited donor site, invasive, longer recovery
Allografts	Moderate bone loss, non-invasive	Readily available, less invasive	Risk of disease transmission, slower integration
Xenografts	Larger defects, long-term restoration	Biocompatible, effective for larger defects	Slower healing, limited incorporation into host bone
Alloplastic Materials	Small bone defects, less expensive	No risk of disease transmission, easy to handle	Less predictable, may not integrate as well as other graft types

- **Digital implant planning** and guided surgery ensure optimal placement.
- **CAD/CAM abutments** provide precise fit and improved stress distribution.
- **Smart implants** with embedded sensors can detect early biomechanical failures.

Nanotechnology and surface modifications are also being explored to enhance implant durability^[15].

Laser-assisted procedures have become increasingly popular in the restoration of fractured implants, particularly for soft tissue management around the implant site. Lasers can help in reshaping the gum tissue, improving aesthetics, and providing a more comfortable experience for the patient during restorative treatments. They are also used for decapping or removal of fractured abutments.

Surgical Considerations in the Management of Fractured Implants and Components:

Surgical intervention is often necessary when a fractured implant or its components cannot be managed conservatively. This may include situations where the implant itself has fractured or where the damage to the prosthetic components (such as abutments or crowns) is severe. Surgical techniques for the management of fractured implants and components vary depending on factors such as implant location, degree of fracture, bone condition, and surrounding soft tissue health. The goal of surgical management is to restore function, preserve bone, and minimize any aesthetic

compromise. This section outlines various surgical approaches, techniques, and their outcomes, providing an in-depth understanding of the surgical management of fractured implants and components^[16].

Removal of Fractured Implants:

When a fractured implant cannot be salvaged, the first step is implant removal. This procedure requires careful planning and execution to avoid causing additional damage to the surrounding bone and soft tissues. Several methods can be employed depending on the implant fracture's severity and the surrounding anatomical features.

Implant removal methods depend on the fracture location and implant status. Rotational instruments are used for fractures above bone level, offering a minimally invasive, quicker procedure but may be ineffective for deeply embedded implants. Trephine burs are preferred for deeply integrated implants as they allow removal but carry a risk of bone damage and may require bone grafting. Surgical flap approaches provide excellent access in cases with significant tissue damage but are more invasive and require flap closure and post-operative care. Ultrasonic devices enable precise, less traumatic removal of fractured implants in hard-to-reach areas, though they come with high costs and require specialized equipment^[17]. This is illustrated in Table 3.

A thorough clinical and radiographic assessment is done to evaluate the implant position, fracture extent, and bone quality.

Bone Grafting and Site Preparation:

In many cases, implant removal leads to a defect in the surrounding bone, especially if the implant has been in place for a long period. This is often the case with large implant fractures or when poor osseointegration is present. Bone grafting procedures are essential to restore the bone volume and provide a stable foundation for a new implant.

Bone grafting is often required following implant removal to restore lost bone volume. Autografts are indicated for significant bone loss, offer optimal biological compatibility, and excellent healing, but involve invasive procedures and limited donor site availability. Allografts are used for moderate bone loss, are less invasive, and readily available but carry a risk of disease transmission and slower integration. Xenografts suit larger defects and long-term restoration due to biocompatibility but also heal slower and incorporate less fully. Alloplastic materials are preferred for small defects as they are inexpensive and easy to handle but tend to integrate less predictably than biological grafts^[18]. This is illustrated in Table 4.

Surgical Techniques for Managing Fractured Components:-

In cases where the prosthetic components (e.g., abutments, screws) have fractured but the implant remains intact, surgical intervention may still be required to access the fractured component and remove it. The most common surgical techniques for this scenario involve creating a flap to access the damaged components.

Flap Surgery for Component Removal:

Flap surgery may be necessary to access and retrieve fractured components that cannot be removed with conventional methods. A well-planned flap approach ensures minimal damage to the surrounding tissues while allowing for effective access to the fractured part.

Prognosis and Long-Term Outcomes:

The prognosis depends on early detection, appropriate intervention, and adherence to prosthodontic principles. Studies suggest that mechanical complications such as screw fractures are relatively common (2%–10%) but manageable if addressed promptly. Implant body fractures, while rare (<1%), often require surgical removal and are associated with greater morbidity^[19].

Preventive Strategies:

The prevention of implant fractures and component failure is a crucial aspect of successful prosthodontic treatment. Preventive strategies aim to reduce the likelihood of complications and extend the

lifespan of dental implants and their components. These strategies encompass a wide range of factors, including patient education, proper implant placement, maintenance protocols, and the use of preventive materials. By addressing these factors early in the treatment process, the risk of failure due to occlusal overload, infection, or material fatigue can be significantly minimized.

Patient Education:

A key element in the prevention of implant-related complications is patient education. Patients must understand the importance of maintaining oral hygiene, following post-surgical care instructions, and adhering to routine check-ups. Proper patient education can also help in minimizing habits such as bruxism or clenching, which are significant risk factors for implant fractures. The following educational aspects should be emphasized:

- **Oral Hygiene:** Proper cleaning and maintenance around implants are vital to preventing peri-implantitis and implant failure. Patients should be taught effective brushing techniques and the use of interdental brushes or floss to keep the area around the implant free from bacterial accumulation.
- **Avoiding Excessive Force:** Bruxism and clenching should be identified early, and appropriate measures, such as the use of night guards or occlusal splints, should be suggested.
- **Regular Check-ups:** Periodic follow-ups with the dentist are necessary to monitor the condition of the implant and components, identify early signs of complications, and intervene before significant damage occurs.

CONCLUSION:

Fractures of dental implants and their components present significant clinical challenges that necessitate a multidisciplinary approach. Prosthodontists must be well-versed in identifying the causes, managing complications, and implementing strategies for prevention. Through careful planning, proper occlusal design, and regular maintenance, the risk of such complications can be significantly reduced, ensuring long-term success and patient satisfaction.

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Conflicts of Interest

There are no conflicts of interest.

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