# Implant abutment screw loosening and management: A narrative review.

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## Abstract

**Objective:** To provide knowledge and to understand the causes, clinical impact and management of implant abutment screw loosening.

**Background:** Implant-supported prostheses are a cornerstone of restorative dentistry due to their high success rates and functional outcomes. Abutment screw loosening, a common mechanical complication remains a challenge, particularly in posterior single-implant restorations and systems with external connections.

**Methodology:** An electronic search of various published articles were collected from PubMed and Google Scholar and reviewed systematically between 1995 and 2025 years.

**Discussion:** Abutment screw loosening is influenced by preload loss, connection design, material properties, and occlusal forces. Various studies have highlighted the importance of optimized torque, coated screws, and sealing agents. Internal and conical connections offer superior stability, reducing micromovements and enhancing long-term implant success.

**Conclusion:** Despite advancements, abutment screw loosening remains a clinical concern. Literature highlights the need for standardized protocols and long-term studies to improve prevention, emphasizing the importance of focused research and clearer clinical guidelines.

**Keywords:** Abutment screw loosening, Dental implants, Implant-abutment connection, Preload.

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## Introduction

The rehabilitation of missing teeth with implant-supported prostheses has become a widely adopted treatment approach, particularly since the advent of osseointegration. The firm integration of a titanium implant into the surrounding bone is considered a critical factor for the long-term success of dental implants. Despite high success rates, long-term follow-up studies have reported various complications arising after the prosthetic phase. These include loss of osseointegration, abutment screw loosening, abutment screw fracture, and other mechanical or biological issues. Among these, abutment screw loosening is the most commonly encountered mechanical complication. It is especially prevalent in single-implant restorations, particularly those using external connection systems and located in the posterior (molar) regions. Contributing factors to screw loosening include insufficient preload during torque application, occlusal overload, prosthetic misfit, and incompatibility between implant and abutment components. This review aims to consolidate current knowledge regarding abutment screw

loosening, examine contributing clinical and biomechanical factors, identify gaps in existing literature, and propose directions for future research to improve the long-term stability and success of implant-supported restorations.

## Methodology:

A systematic electronic search was conducted using PubMed and Google Scholar to identify relevant published articles from 1995 to 2025. Studies focusing on implant abutment screw loosening, its causes, clinical implications, and management strategies were reviewed and analyzed.

### Causes, clinical impact and management of implant abutment screw loosening

### Implant- abutment connection:

The implant-abutment connection (IAC) is considered one of the most critical factors influencing the long-term success of dental implants and the health of the surrounding peri-implant tissues.[1] In two-piece implant systems, a microgap typically exists at the IAC interface.[2] This microgap can range in size from approximately 10 to 135 μm and has been associated with both mechanical and biological complications.[3]

This interface between the prosthetic abutment and the dental implant often serves as a potential reservoir for microbial colonization. Micromovements occurring at the abutment level can facilitate the bidirectional migration of bacteria between the internal surfaces of the implant system and the IAC, potentially leading to infection of the peri-implant tissues.[4] Furthermore, abutment screw loosening may exacerbate this issue by increasing the likelihood of microbial infiltration, ultimately compromising implant stability and increasing the risk of failure. Therefore, preventing screw loosening is essential to maintaining the integrity and longevity of implant-supported restorations. [5-7]

### Mechanism of the abutment screw loosening:

In most implant systems, the abutment screw plays a crucial role in maintaining the integrity of the implant-abutment connection. When the screw is tightened, it undergoes elastic deformation and elongation, generating a tensile force referred to as preload.[8,9] This preload acts as a clamping force that holds the implant and abutment together, functioning much like a tensioned spring. The magnitude of the preload is critical, as it directly influences the stability of the implant-abutment interface by maintaining sufficient compressive force to resist micromovements and mechanical disruption.

Bickford described the process of screw loosening as occurring in two distinct stages. In the first stage, external forces acting on the implant system reduce the screw's initial tensile deformation, thereby diminishing the clamping force. In the second stage, continued loss of preload leads to increased micromovement at the implant-abutment interface, ultimately compromising the mechanical integrity of the connection and resulting in screw loosening. Thus, loss of preload, primarily due to the effects of external loading, is a major contributor to abutment screw loosening (Figure 1) and must be carefully managed to maintain prosthetic stability.[10]

There is a direct correlation between the magnitude of the tightening torque applied to the abutment screw and the resulting preload. However, increasing the tightening force and preload does not always equate to enhanced clinical performance, as the abutment screw functions within a range of elastic deformation. If the applied preload exceeds

the yield strength of the screw material, permanent deformation may occur, compromising the mechanical integrity of the connection. This can lead to screw loosening or even fracture. Therefore, to ensure optimal performance and longevity, the recommended preload typically falls within 60% to 80% of the material's yield strength. [7,11,12]

**Factors affecting abutment screw loosening:**

The stability of the implant-abutment interface is influenced by various mechanical and prosthetic factors. Position and occlusal scheme, variations in hex dimensions, differences in abutment counterparts, misfit or inaccuracies at the interface, abutment tension, suboptimal screw design, and excessive occlusal forces all contribute to the potential for screw loosening.

## Preload

Preload refers to the clamping force generated when the abutment screw is tightened, which holds the implant and abutment securely together. Proper torque application is essential to prevent screw loosening, and the use of calibrated torque wrenches ensures accurate and consistent torque values. Applying torque in a stepwise manner helps achieve optimal preload and reduces micromovements at the implant-abutment interface. Seloto CB et al reported that the application of sealing agents contributes to the maintenance of preload by increasing detorque values.[13]

## Screw material

The choice of abutment material significantly influences screw stability. Titanium abutments are widely used due to their excellent mechanical properties and biocompatibility. However, studies have shown that “gold alloy retention” screws with gold coating and titanium alloy screws with aluminum titanium nitride (AlTiN) coatings retain a lower percentage of their initial torque, potentially compromising preload maintenance. Conversely, zirconia abutments have demonstrated superior biomechanical stability and a reduced incidence of screw loosening.[14]

## Connection geometry and screw design

The geometry of the implant-abutment connection and screw design plays a pivotal role in resisting loosening. Several connection types have been evaluated in the literature:

- **External Hex Connection**: This traditional design has shown higher susceptibility to screw loosening due to its limited resistance to rotational forces and tendency to create microgaps and micromovements at the interface.
- **Internal Hex Connection**: Offering a more conical and precise fit, this design demonstrates improved resistance to rotational forces and minimizes micromotion, thus reducing the risk of screw loosening.[13]
- **Morse Taper Connection**: Also known as an internal taper, this connection exhibits excellent stability due to its conical design, which provides a frictional fit with high resistance to rotation and effective stress distribution, significantly reducing screw loosening.[15]
- **Tri-Channel Connection**: Designed with three interlocking channels, tri-channel systems enhance rotational stability. Studies report promising outcomes in minimizing abutment screw loosening with this design.[16]
- **Helical Thread Design**: Screws featuring helical or reverse threads, finer pitches, and self-tapping properties have demonstrated improved mechanical engagement and superior resistance to

loosening compared to conventional thread designs.[17]

## Screw coating and surface treatments

Surface coatings such as titanium nitride (TiN) and diamond-like carbon (DLC) have been investigated for their ability to enhance screw retention. These coatings improve the frictional engagement between screw and implant components. Jung SW et al found that TiN-coated abutment screws significantly reduce the incidence of screw loosening.[18]

### Settling Effect

The settling effect refers to the loss of preload resulting from the flattening of surface irregularities under load shortly after torque application. When the magnitude of settling exceeds the elastic elongation of the screw, a loss of clamping force occurs, potentially leading to screw loosening. It is estimated that 2–10% of the initial preload is lost within the first few seconds or minutes due to this effect.[19]

### Implant Number and Diameter

The number and diameter of implants used in a prosthesis influence load distribution. Single implant restorations are more prone to screw loosening due to concentrated stress, whereas multiple implants provide better load sharing, reducing the stress on individual screws. Similarly, implants with wider diameters enhance mechanical stability and decrease the risk of screw loosening by providing a broader load-bearing surface.[20]

### Screw Sealers

Screw sealers—gel or liquid materials applied to the threads before tightening—have been explored as a method to enhance screw retention and prevent loosening. Emanuel Adrian Bratu et al investigated the use of screw sealers in implant-abutment fixation and reported improved stability.[21]

### Thread Sealing Compounds

Thread sealing compounds, including anaerobic adhesives and thread-locking agents (Figure 2 and 3), are designed to fill microscopic gaps between the screw threads. These agents increase frictional resistance, reduce micro-movement, and contribute to long-term screw stability.[21]

## Discussion:

Abutment screw loosening remains a prevalent mechanical complication in implant dentistry, influenced by multiple biomechanical and prosthetic factors. Bickford et al[10] described screw loosening as a result of reduced preload due to functional loading, which compromises the clamping force and leads to micromovements. Seloto CB et al[13] emphasized the role of sealing agents in maintaining preload, while Bratu et al[21] demonstrated improved screw retention using thread-locking agents. Connection geometry significantly affects joint stability. Kano SC et al [9] reported that internal and Morse taper connections offer superior resistance to micromovement compared to external hex systems. Similarly, Jung SW et al[18] found that titanium nitride-coated screws show better resistance to loosening than uncoated or gold-coated screws.

The settling effect, as noted by Seddigh MA et al[19], leads to early preload loss, underscoring the need for retorquing protocols. Collectively, these findings reinforce that effective management of preload, selection of appropriate connection designs and materials, and attention to occlusal dynamics are key to minimizing screw loosening and improving implant longevity.

## Conclusion:

Abutment screw loosening is one of the most prevalent mechanical complications associated with implant-supported

restorations. A clear understanding of its underlying causes and contributing factors enables clinicians to make more informed decisions in clinical practice. The loss of torque or preload remains a primary challenge in maintaining the mechanical integrity of implant restorations. While various factors may increase or decrease the likelihood of screw loosening, there is a lack of comprehensive comparative studies addressing key preventive measures. Therefore, additional research is needed to develop evidence-based guidelines aimed at reducing screw loosening and improving the long-term success of implant-supported restorations.

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## FIGURES

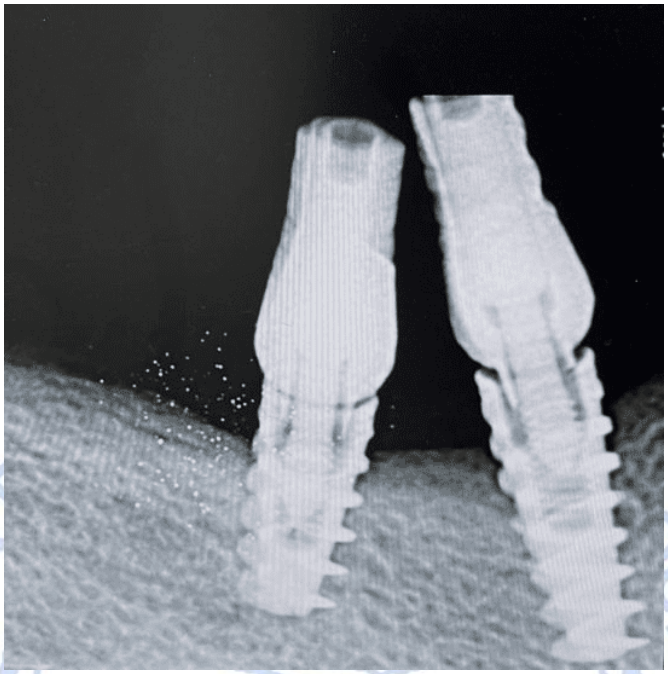

Figure 1


Figure 2

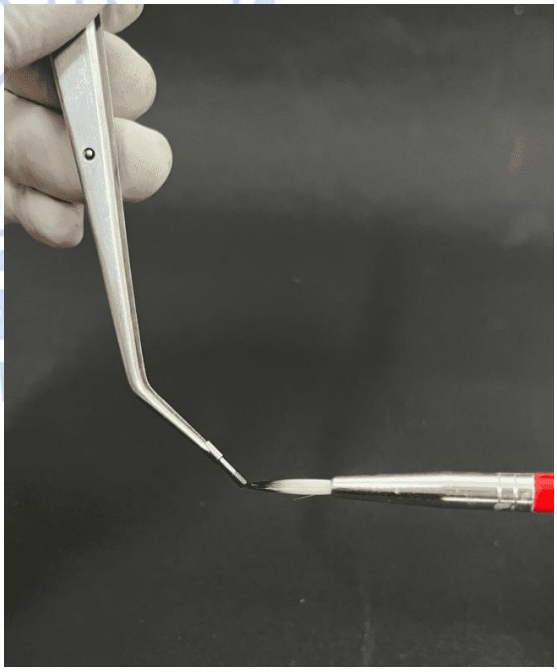

Figure 3