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Exploring the Causes and Management of Dental Implant Failures- A Review

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Review Article

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ABSTRACT

Background: Osseointegrated dental implants have been considered the most esthetical and functional alternative to missing teeth. However, the treatment is not always successful resulting in implant loss. The implant loss can be attributed to factors such as biological, microbiological, and biomechanical, but the cause and mechanism of the early implant failure are still obscure. Dental implant failure has led to continuous innovations of various implant systems and to different interceptive treatment modalities. These concerns have also led to the selection of implant designs that best suit the various types of bone. There are a variety of reasons for the failure of endosseous implants. Different reasons for implant failure and their contributing factors have been discussed in the review article.

Materials and Methods: Failure of dental implants has been the subject of a comprehensive electronic literature search from 2003 to 2023 using PubMed and Google Scholar databases with relevant MeSH terms and keywords. The causes and management of dental implant failures were used to identify studies for this review. Selected article references were checked to expand the article search.

Results: The search strategy yielded 65 titles. Twenty articles that met our inclusion criteria were included in the qualitative analysis. The result shows that the most common type of implant failure is caused either by poor treatment planning or poor surgical execution. To optimize the treatment outcome through dental implants, etiology and factors associated with implant failures should be taken into consideration. Such knowledge is needed for developing adequate treatment and prevention strategies.

Conclusion: Identification of the etiology, current condition, and the proper protocol for the various treatment options will reduce the various hitches in implant surgery. Follow-ups and reviews during the osteointegration phase would definitely minimize the post-surgical complications.

Keywords: Failed Implant, Endosseous Dental Implants, Re-implantation, Implant Restorations, Implant Survival.

Introduction

Dental implants have become a widely accepted and successful solution for replacing missing teeth, providing patients with improved function, aesthetics, and overall oral health. However, despite their high success rates, there are instances where dental implants may fail. Understanding the factors contributing to implant failure is crucial for both dental professionals and patients to optimize treatment outcomes. Implant failure can result from a combination of biological, mechanical, and patient-related factors. Biological factors include issues such as inadequate bone quantity or quality, improper implant placement, and peri-implantitis—an inflammatory condition affecting the tissues surrounding the implant. Mechanical factors encompass problems related to the implant components, prosthetic restoration, or occlusal forces that may exceed the implant's capacity.[1] Patient-related factors involve lifestyle choices, oral hygiene practices, and systemic health issues that can impact the success of dental implants.[2] This review will delve into the multifaceted nature of dental implant failure, exploring the various challenges faced by both clinicians and patients. By examining the root causes of implant failure, we can develop a comprehensive understanding of how to prevent and address these issues, ultimately enhancing the long-term success and sustainability of dental implant treatments.

Materials and Methods

The failure of dental implant has been the subject of a comprehensive electronic literature search from 2003 to 2023 using PubMed and Google Scholar databases with relevant MeSH terms and keywords. Combinations of the following keywords were used for the identification of the studies to be considered in this review: "failed implants," "implant survival". To broaden the search for relevant articles, selected article references were reviewed.(Figure 1)

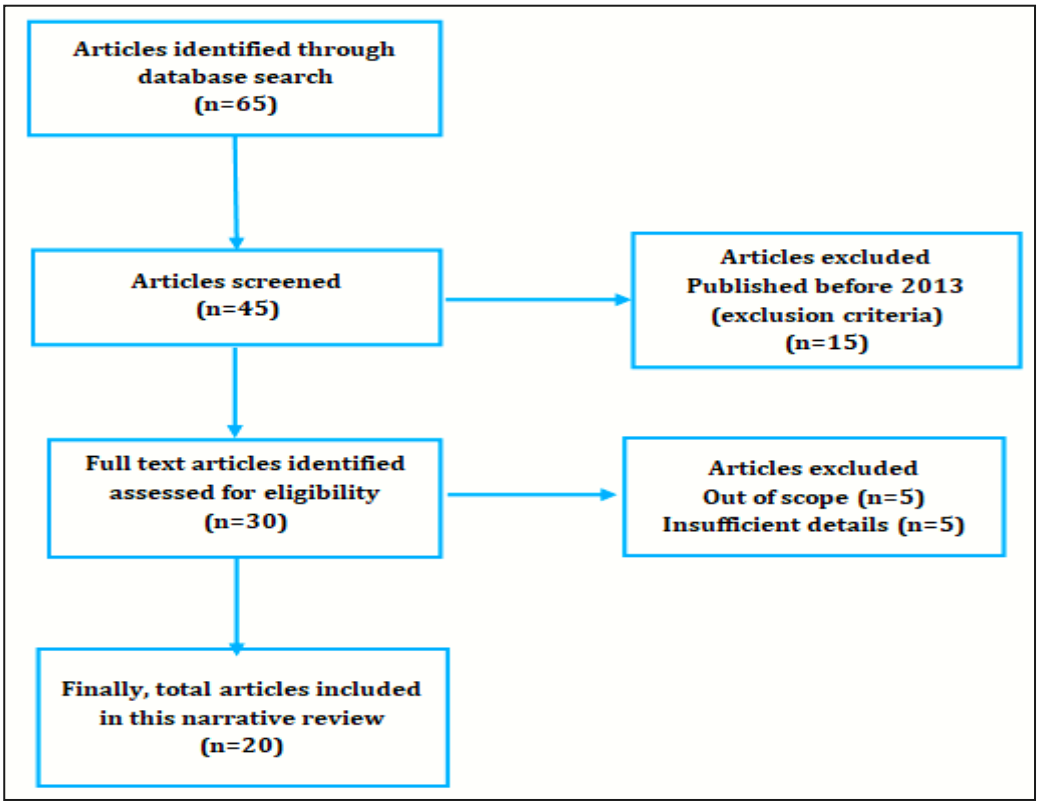

Figure 1: PRISMA flow diagram of articles screening and selection.

This study is to find similar topics from several articles that will be reviewed and summarized. PICO was used as a strategy to find the articles:

- **Patient/Population (P):** Adult patients with dental implants.
- **Intervention (I):** Regular professional maintenance and meticulous oral hygiene practices.
- **Comparison (C):** Standard care without specific maintenance protocols.
- **Outcome (O):** Incidence of implant failure and long-term success.

The eligibility criteria were as follows.

Inclusion criteria:

- Studies involving causes and management of dental implant failures.

Exclusion criteria:

- Case reports, case series.

Implant Failure: Dental implant survival depends on successful osseointegration following placement. Excessive surgical trauma, infection, or metabolic disorders may adversely affect treatment outcome by altering the biological process. As an implant is restored and placed in function, bone remodeling becomes a critical aspect of implant survival in response to the functional demands placed on the implant restoration and supporting bone.[3]

Etiology of Dental Implant Failure

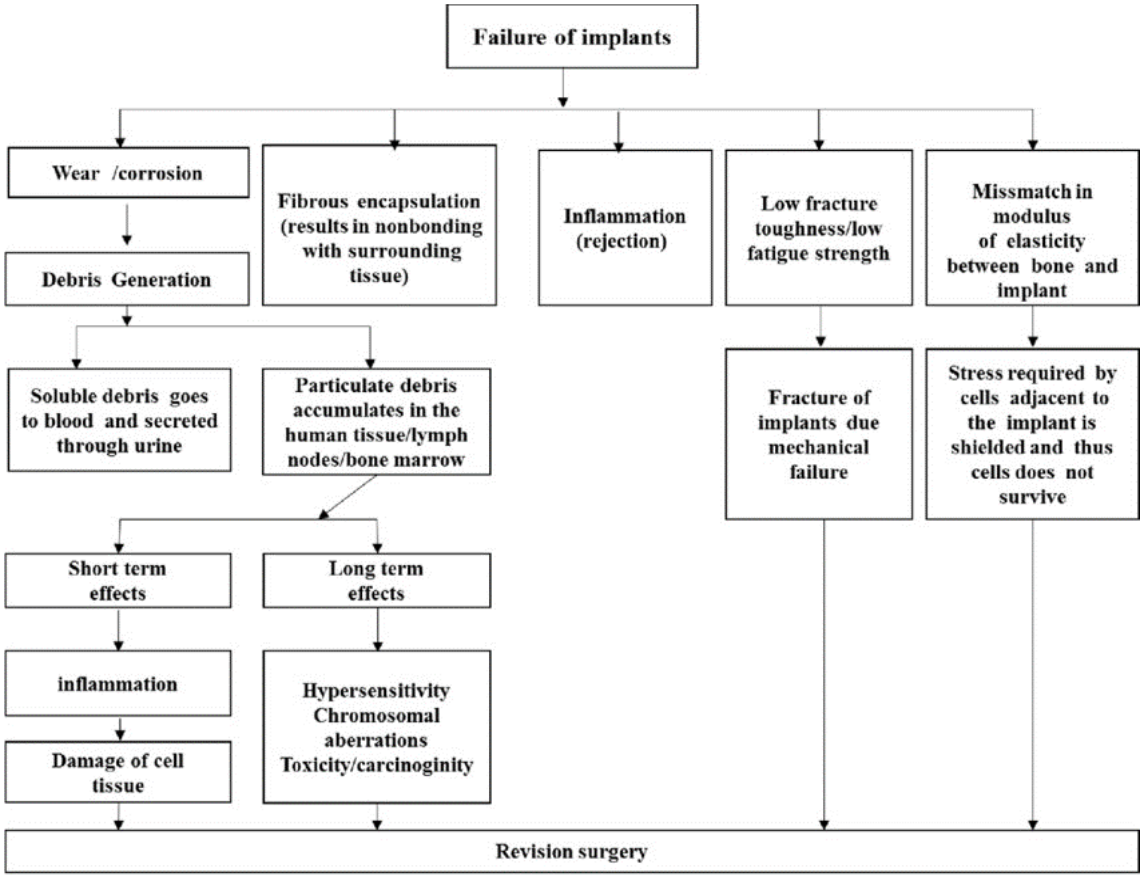

Figure 2: Causes of implant failure Pic Courtesy: Hussein MA-2015[4]

Parameters for the Evaluation of Implant Failure

Although it is probable to differentiate between a successful and a failed implant clearly, it still remains challenging to identify failing implants. Esposito et al. discussed the parameters, which have been employed clinically to evaluate implant conditions. The most common diagnostic criteria established for the implant failures (failed implants) are as follows.

Clinical Signs of Early Infection: Signs of infection which occur during the early stage of healing are more critical than if they occur at a later stage. Infection occurring at an early stage will lead to disturbance in the osseointegration of the implant to the surrounding bone. The most common complications seen are swelling, fistulas, suppuration, early/late mucosal dehiscences, and osteomyelitis during the healing period (3–9 months) which indicates implant failure. Mombelli et al. compared clinical and microbiological finding related to healthy and failing dental implants. Futile implant sites were categorized by probing depths of 6 mm or greater in association with suppuration, bone loss, and microbiota consisting primarily of Gram-negative anaerobic rods.[5]

Discomfort or Sensitivity: Pain or discomfort is the first sign which indicates an implant failure and is often associated with mobility.[6]

Clinically Distinct Movement: Several different types of mobility have been recognized as: (1) Rotation mobility, (2) lateral or horizontal mobility, and (3) axial or vertical mobility.Sometimes, clinically apparent movement of the implant can be present minus distinct radiographic bone changes. Therefore, mobility is the cardinal sign of implant failure.[6]

Radiographic Signs of Failure: There can be two distinct radiographic pictures of implant failure. First is a thin perifixtural radiolucency surrounding the entire implant. This suggests the absence of direct bone-implant contact and possibly a loss of stability. The second is an increased marginal bone loss. When a suspected perifixtural radiolucency or excessive marginal bone loss is observed, it is recommended to remove the prosthetic construction and check the implants for stability. Clinically noticeable mobility after framework removal will endorse the reasonable radiographic identification of implant failure.[7]

Dull Sound at Percussion: A subdued sound on percussion is indicative of soft tissue encapsulation. A clear crystallization sound indicates successful osseointegration.[7]

Bleeding on Probing: Bleeding on probing has been a measure of peri-implant tissue conditions. However, recent findings suggest that it cannot be used to discriminate between a healthy and diseased peri-implant state and it has no scientific evidence to support it. El Askary et al. in 1999 gave eight warning signs of implant failure which are(i) connecting screw loosening (ii) connecting screw fracture (iii) gingival bleeding and enlargement (iv) purulent exudates (v) pain (not very common) (vi) fracture of prosthetic component (vii) angular bone loss and (viii) long-standing infection and soft tissue sloughing.[7]

Stages of Implant Failure

Many causes have been studied on the subject of implant failures. Implant failure can occur at any time during treatment and subsequently when the implant is in function. So, according to timing of failure it can be • Before stage II (after surgery) • At stage II (with healing head and/or abutment insertion) • After restoration.

Before stage II: It usually occurs as a result of Implant misplacement, that is, placement of the implant in an infected socket, pathological lesion, or immature bone previously augmented or placement of a contaminated implant in the osteotomy, infection or soft tissue complications. The failed dental implant may appear to be an exfoliating fixture accompanied by purulent

exudates. In this particular situation, it starts first with exposure of the cover screw, which when palpated with a light touch of a probe on top of the screw, reveals a sinking or damping movement due to the fibrous tissues and the infection surrounding the fixture. It may terminate with exfoliation of the fixture in 10 days to 2 months from the time of fixture placement.[8]

At stage II: Implants can fail at the second stage of surgery, during healing or head placement, at abutment connection, and before prosthetic placement. This could be due to excessive torquing during abutment connection when inserted into the grafted bone. It probably happens because of an insufficient bone contact surface area with the implant and possibly because of poor surface treatment of the fixture. A contaminated implant may stay in a dormant condition until torque is applied to the cover screw. Then it comes out because of lack of integration, which can result from the implant being placed in a wide osteotomy, the implant being loaded before the recommended time, or traumatic placement of the implant. It cannot be considered an early failure because it is not early enough, and it is not a late failure because it happened before prosthetic placement.[9]

After restoration: This particular timing of failure is most common. It starts after an integrated implant is loaded and leads up to the point of discovery of the failure. The most common cause is occlusal trauma. It has its own clinical manifestations, known as peri-implantitis.[9]

Management of Implant Failure

a. Diagnose and identify the failed implant.
b. Note the clinical signs: Mobility, edema, pain, pus, bleeding and radiographic signs of peri-implant bone loss.
c. In any case of implant failure where mobility is apparent, the implant should be removed immediately.
d. Replacement of failed implant[10]

Methods of Implant Removal

A mobile implant may easily be removed by rotating it counter clockwise using a driver, counter-torque ratchet technique (CTRT), or forceps. Rotating with minimum luxation allows reduced trauma and damage to the surrounding bone and soft tissue. Methods of immobile implant removal include: use of counter torque ratchets, screw removal devices, piezo tips, high-speed burs, elevators, forceps and trephine burs. The CTRT is the least invasive technique for removing an implant without damaging surrounding structures. The use of CTRT should be considered only if the implant is able to be engaged and reverse-torqued until mobile. The reverse screw technique (RST) is indicated in the removal of a fractured implant when the connection is damaged or in the removal of an external connection implant when the ratchet cannot be engaged to use the CTRT. Piezo tips and high-speed burs can be used in conditions where CTRT and RST are not useful to loosen the abutment.[11]

Treatment Alternatives Following Removal of Failed Implants

The literature pertaining to treatment alternatives following the loss of dental implants could best be described as negligible. The decision as to which of these alternatives should be selected is complex and involves both biological and mechanical considerations, as well as psychological aspects with financial considerations being a silent partner. The treatment of choice should be a team decision with the surgeon, restoring clinician and patient having an equal say in the final outcome.[12]

Implant Maintenance

One of the key factors for the long-term success of implants is the maintenance of the healthy tissues around it. The implant should have accessible embrasure widths for maintenance with polished collars for the prevention of plaque formations. Scaling is to be done delicately to avoid scratches with a plastic scaler. Chlorhexidine gluconate may be used as an irrigant. The patient must be asked to maintain plaque control. A soft or extra soft

toothbrush must be used. Use of floss and interdental aids may be encouraged.[13]

Discussion

The literature was systematically searched and included electronic databases and hand-searching of relevant journals. Sixty-five studies were accepted for the present review. However, of those, only twenty-five studies were eligible for this review article. Implants are suspected to fail from traumatic conditions if the following conditions, i.e., radiographic peri-implant radiolucency, mobility, lack of glaucomatous tissue on removal, lack of increased probing depths and low plaque, and gingival indices exist. Truhlar classified failures as early and late failures. Early failures occur within weeks to a few months after placement. They were caused by factors that can interfere with normal healing processes or by an altered healing response. Late failures were those that arose from pathologic processes that involved a previously osseointegrated implant. Heydenrijik et al. classified implant failures are referring to the occurrence in time as early failures, in which osseointegration had never been established, thus representing an interference with the healing process. Late failures are the ones in which osseointegration was not maintained implying processes involve loss of osseointegration. Soon late failures referred to implants failing during the 1st year of loading and delayed late failures referred to implants failing in subsequent years.[14]

Factors Related to Patient History

Patient Demographics and Medical History

Many patients seeking implant rehabilitation are of an advanced age, which increases the prevalence of systemic medical problems such as diabetes and osteoporosis. These disorders could exert harmful effects on bone metabolism and thereby endanger the integrity of osseointegration. Nonetheless, the results obtained in this review indicate that only radiation therapy could significantly increase the risk of late failure, but not sex, age or medical problems. Radiation therapy (including radiotherapy and radiochemotherapy) could compromise the oral environment so as to significantly increase the risk of late failure. A previous review of medically compromised patients performed in 2014 also supported this finding.

Regarding the oral history, a history of periodontitis is an important risk factor for late failure. Periodontitis is one of the main reasons for tooth loss that leads to a requirement for implant rehabilitation. Moreover, a previous review indicated that a history of periodontitis could be considered a predictor of peri-implantitis that could lead to late failure. Jemt et al. reported that a history of periodontitis was significantly associated with inflammation at the implant side that could cause peri-implantitis. This effect could be due to the transmission of periodontal pathogens from the teeth to the implant. Only one study found no association between an initial diagnosis of periodontitis and late implant failure, but that study only investigated implant loss rather than the peri-implantitis that is one of the indicators of late failure.

It is particularly interesting that two studies found that all subjects with late loss also experienced at least one early loss. Although no statistical analysis was performed, clinicians should be mindful of a strong correlation between early and late implant loss when treating patients with a history of early loss.[15]

Habits

Smoking causes several local and systemic diseases and jeopardizes both bone and wound healing processes. Despite all the relevant studies in this review supporting an association between smoking and an increased risk of late failure, the results were not statistically significant. Moreover, the literature supports that smoking significantly affects early failure and exerts a dose-related effect on late failure of dental implant. Thus, clinicians should apply caution toward and adequately inform smoking patients before giving them implant treatment.

Bruxism seems to be the most important risk factor endangering the implant survival rate. Bruxism is associated with large and unpredictable occlusal forces that could cause various types of complications during implant treatment, including both biological and mechanical complications such as bone loss around the implant, prosthesis wear or fracture, screw loosening, and fixture fracture. Since the prevalence of people with bruxism is common, implant treatment in this population is inevitable. Despite numerous studies finding that bruxism had a negative effect on implant outcomes, we were unable to draw any definitive conclusion about whether or not bruxism is a significant risk factor for late failure. This finding is consistent with a previous review and it could be due to the lack of published studies, the smallness of the analyzed samples, or lack of bruxism-specific diagnosis methods. Moreover, the close attention paid by clinicians to bruxism patients along with the application of meticulous treatment plans and regular follow-ups could reduce the real effect of this parafunction on the outcome of dental implants.[16]

Factors Related to Clinical Parameters

Implant Location

Placing an implant in a posterior location was reported as a significant risk factor for late failure, although a few studies have not found a significant association. A significant association finding could be due to posterior teeth being subjected to threefold-higher occlusal forces than the anterior teeth. Posterior regions are also known to be at a higher risk of dental plaque accumulation compared to anterior regions and plaque accumulation is associated with gingival inflammation and the initiation of several oral diseases that could lead to failure of dental implant.

Despite implant placement in the maxilla being found to be a significant risk factor for early failure, its influence on late failure remains controversial. While most studies have found that whether an implant is placed in the maxilla or mandible does not significantly influence late failure, there are some that have indicated that either the maxilla or the mandible could be a risk factor for late failure. Late failure could be associated with implant placement in the maxilla due to the trabecular bone being less dense and the cortical bone being thinner compared to the mandible. The weaker bone structure could decrease the initial stability, which is a risk factor for late failure of dental implants. Meanwhile, the reason for the association between late failure and implant placement in the mandible remains unclear.[17]

Bone Condition

The demand for implant placement is higher among elderly women since they are prone to greater osteopenia or osteoporosis. Although these bone metabolic diseases could have a negative impact on implant stability and have shown trends for more late failures, no significant associations between these bone conditions and late failure have been found. Neither a lack of bone volume nor the presence of bone dehiscence or fenestration significantly affected the rate of late failures. Moreover, bone augmentation may have a protective effect on implant outcomes, as demonstrated by a significantly lower peri-implantitis rate and a higher survival rate.

While the bone condition and bone volume did not significantly influence the rate of late failures of dental implant, a low bone density poses a significant threat to implant outcome. Low bone quality, especially type IV (thin cortical bone with a low density of trabecular bone), was found to significantly increase both the late- and early-failure rates. Poor bone quality was reported to be significantly associated with low initial stability, which is a significant risk factor for late failure. This finding has also been found in other previous studies.[18]

Adjacent Dentition

Only one study found that the presence of more than 20 remaining teeth could significantly

increase the late failure rate. The reason behind it remains unclear. Therefore, future well-controlled studies are necessary to clarify this finding.

Regarding the opposing dentition to a dental implant, a partial or a complete removable denture was reported to be a significant risk factor for late failure. The difficulty in occlusion adjustment and the complication of force distribution on the removable denture could contribute to this finding, but an earlier report indicated that opposing dentition was not a risk factor for late failure. Therefore, careful prosthesis planning and meticulous occlusal adjustment are mandatory for the implant long-term success.[19]

Factors Related to Decisions Made by the Doctor

Implant Selection

Despite the implant design and surface treatment not significantly influencing late failure of dental implant, there was a tendency for implants with a machined surface to be associated with a higher failure rate. Moreover, a conventional threaded implant (≥10 mm long) with an SLA surface had a more favorable outcome when treating patients with an adequate bone volume, whereas a short press-fit implant (≤7 mm long) with an SPS showed a better outcome in a case of advanced bone resorption (bone height < 5 mm).

It is advisable to place a short implant when the bone height is inadequate. However, this strategy should be performed with caution in immediately loaded implants, for which short implants were associated with a significant decrease in implant success. The reduced bone-implant interface of a short implant may not allow for sufficient initial stability that is the main requirement of this technique. On the other hand, when using a surgical guide for implant placement, implants longer than 10 mm were likely to have more late failures than shorter implants. This observation is probably due to bone overheating resulting from inadequate coolant irrigation and the accumulation of bone dust while drilling.

Alsaadi et al. found an increased rate of late failure among large-diameter implants, but this could have been due to the surgeon being inexperienced or wide implants usually being employed as “rescue” implants. It should be noted that several studies found that there was no significant correlation between implant width and late failure.

We found that the implant brand does not appear to significantly influence the late-failure rate, as also found by Manor et al. In contrast, a subsequent study reported in 2015 found that a Straumann implant with an SLA surface produced a significantly more favorable outcome than several other rare implant brands (which have not been widely used and even discontinued in the market), such as Biomet 3i, CrescoTi, XiVE, Frialit, and Lifecore. Jemt et al. found that the NobelActive conical connection implant recently exhibited a significantly higher late-failure rate than other implant types, but that implant system had been used to treat more complicated conditions than the other implant systems in that study. It is therefore difficult to interpret these results due to the differences in clinical use and clinician experience among the studies. While it is feasible that the implant brand could impact the late-failure rate of dental implants, we believe that the available evidence indicates there is no significant effect.

The investigations perform in this review suggest that the implant selected does not play an important role in late failure. However, clinicians should pay more attention in certain circumstances such as during implant placement with a surgical guide and immediately loaded implants.[20]

Surgical Procedure

A two-stage surgical protocol has been recommended for implant placement since being introduced by Branemark. However, this strategy has been changing to a one-stage, immediate-placement protocol due to its benefit of reducing the treatment time. A study reported in 2011 found that the time of implantation did not

significantly influence the late failure rate. Nonetheless, it was subsequently found in 2017 that using a two-stage protocol was a significant risk factor for late failure of dental implants, which could be explained by most of the two-stage surgical procedures employing a guided bone regeneration procedure, which indicates that they were complicated cases involving severe bone loss.

Several studies have shown that bone augmentation is not significantly associated with late failure. Moreover, implant placement with bone augmentation was found to be likely to have a higher success rate. This protective effect of the bone graft procedure demonstrates that bone grafting is a promising technique for improving bone quantity without compromising the success rate.

A high Periotest value either during implant insertion or at the abutment connection was found to be a significant risk factor for late failure. This parameter is derived from a method measuring implant stability, which indicates that clinicians should have a precise surgical plan in order to obtain a high initial stability during implant placement. A higher rate of late failures when placing more than one implant during implant surgery was reported recently, which could have been due to the extent of bone loss associated with greater tooth loss, iatrogenic failures due to clinician negligence, or fatigue during the extensive surgical intervention.

In addition to the above surgery-related considerations, patient post-surgery follow-up and compliance should also be considered. Most patients report signs of mucosal inflammation or irritation at the implant site before failure actually occurs. An early diagnosis of inflammation at the implant site during the first year was significantly associated with late failure (HR = 17.95). Thus, patient compliance and implementing a maintenance plan after implant surgery could ensure better outcomes.[20]

Prosthesis Design

An implant-supported overdenture provides several benefits over an implant-fixed prosthesis, such as being cheaper and ease of prosthesis maintenance. However, clinicians should avoid using a conus-type connection, which was reported as a significant risk factor for late failure. Further studies are needed to clarify why such connections are associated with late failure of dental implants.[21]

Conclusion

The use of implants is widespread and likely to increase over the next years, which suggests that dental professionals will deal with implant failure and associated consequences more frequently. One must identify the cause to treat the current condition and gain knowledge for future therapies. Timely intervention is always possible with routine checkups. Minimizing the number and severity of issues that will unavoidably arise requires knowledge, learning, and experience.

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