Episode 84 – Peri-implant Diseases **May 12, 2023**

Introduction

Dental implants have changed oral healthcare delivery, providing solutions to various clinical problems previously managed through other approaches. Advances in implant dentistry have allowed implant treatment to become a common and successful therapeutic option to replace missing teeth. Dental implants help to restore function and improve esthetics to enhance quality of life.

Wang et al. (2021) reported on client satisfaction and oral health-related quality of life 10 years after implant placement. Results showed in a sample of 95 participants, mostly restored with single implant-supported crowns or partial fixed dental prostheses, 87% reported high satisfaction after 10 years, while 12% were mostly satisfied. Measures for phonetics, esthetics, and chewing comfort (all indicators of oral health-related quality of life) were high. Restoration cleanability was a concern for several participants with only 66% reporting no concerns. Collectively, these results show implant treatment is a viable option to restore function, esthetics, and overall well-being. [1]

Implants have shown a high degree of predictability, with a survival rate in the range of 90-95% for more than ten years. Nevertheless, the advent of dental implants has given rise to two new oral diseases: peri-implant mucositis and peri-implantitis. [2]

Classification of peri-implant diseases[1]

The 2017 World Workshop on the classification of periodontal and peri-implant diseases and conditions, jointly conducted by the American Academy of Periodontology (AAP) and the European Federation of Periodontology (EFP), produced a revised disease classification system to guide clinician diagnosis and comprehensive treatment planning, while allowing for personalized client care. The updated classification included the first classification for peri-implant diseases and conditions. [3] [4]

Classes of peri-implant diseases and conditions

- **Peri-implant health** is the absence of peri-implant signs of soft tissue inflammation (e.g., no redness, swelling, or profuse bleeding on gentle probing) and no additional bone loss following initial healing.
- **Peri-implant mucositis** is the presence of peri-implant signs of inflammation (redness, swelling, line or drop of bleeding within 30 seconds following gentle

[1] Listen to Episode 46 for initial discussion on the AAP classification of peri-implant diseases and conditions.

probing and/or suppuration on gentle probing or with digital palpitation of peri-implant tissues, soft tissue consistency); increase in probing depths compared to baseline, but no additional bone loss following initial healing.

- **Peri-implantitis** is the presence of peri-implant signs of inflammation (bleeding on gentle probing and/or suppuration); radiographic evidence of bone loss following initial healing; and increasing probing depth as compared to probing depths collected after prosthetic reconstruction. If initial radiographs and probing depths are unavailable, radiographic evidence of bone level ≥3 mm and/or probing depths ≥6 mm in combination with profuse bleeding indicates peri-implantitis.
- **Peri-implant soft and hard tissue deficiencies** are deficiencies at implant sites resulting from various factors that can lead to complications affecting implant survival, such as natural resorption after tooth extraction, trauma, infectious diseases (e.g., periodontitis, peri-implantitis, endodontic infections), growth and development, sinus floor expansion, anatomical preconditions, mechanical overload, thin soft tissues, lack of keratinized mucosa, implant malposition, tooth migration, and systemic diseases. [4] [5] [6] [7] [8]

Prevalence of peri-implant disease

A systematic review and meta-analysis by Lee et al. (2017) found, on average, 29% of implants and 47% of clients had peri-implantitis; and 9% of implants and 20% of clients had peri-implantitis. [9]

A literature search by Salvi et al. (2019) reported a prevalence of 43% (range: 19-65%) for peri-implant mucositis, and 22% (range: 1-47%) for peri-implantitis. [10]

A systematic review and meta-analysis by Diaz et al. (2022) found, on average, 12% of implants and 19% of clients had peri-implantitis. [11]

The wide range in the reported prevalence of both peri-implant mucositis (19-65%) and peri-implantitis (1-47%) illustrates the uncertainty as to how often complications occur. These discrepancies relate to both different populations and different diagnostic criteria. The AAP classification of peri-implant disease should help resolve this uncertainty. [12]

The prevalence also suggests a high percentage of implants can be affected by peri-implant disease. Thus, it is important to understand any risk factors which may be modified to reduce disease occurrence and progression. [9]

Teeth versus implants

As with periodontal health, peri-implant health depends on an equilibrium between the resident oral microbiota and the immunoinflammatory system of the host. Any factor that alters either or both of these components increases the risk of disease. [13]

There are several differences between teeth and dental implants. Teeth have a periodontal ligament connecting the cementum to the bone. Whereas, dental implants are in direct contact with bone (i.e., osseointegration).

Teeth have collagen fibres perpendicular to the long axis of the tooth attaching to the tooth surface. Implants have collagen fibres that are circumferential and parallel to the long axis of the implant and do not attach to the implant surface. Soft tissue of implants has less resistance against probing compared with probing gingival tissues of teeth.

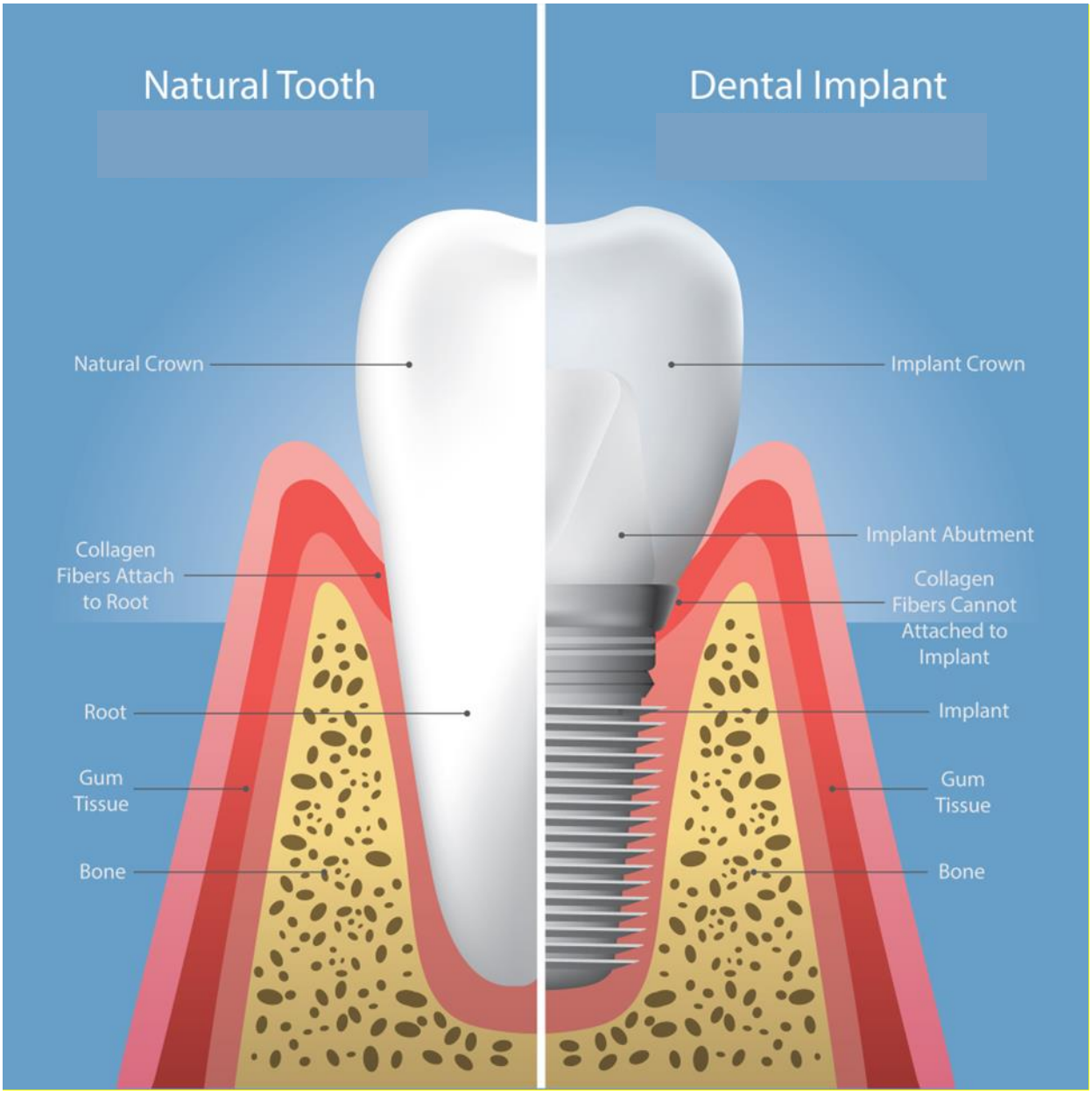
Marginal soft tissue of implants contains less vascular supply than gingival tissues. Connective tissues between teeth and bone possess a higher level of immunocompetent cells providing both cellular and humoral defense mechanisms,[2] compared to dental implants. This may lead to weaker resistance against infections at the soft tissue cuff and the implant surface.

Enamel and cementum may allow different biofilm development than at dental implants. Infections at dental implants may result in different pathogenic microbiota than at tooth surfaces. [14]

Comparison of teeth and dental implants [15] [16]

	Teeth	Dental implants
Connection	Cementum, bone, periodontal ligament	Osseointegration, functional ankylosis (periodontal ligament and cementum absent)
Junctional epithelium	Hemidesmosomes and basal lamina[3]	Hemidesmosomes and basal lamina
Connective tissue	Perpendicular fibres to the long axis of the tooth. Attach to tooth.	Circumferential parallel fibres to the long axis of the implant. Do not attach to implant.
Vascularity	More	Less
Probing depths	≤3 mm in health	≤5 mm (dependent on soft tissue depth)
Bleeding on probing for disease detection	More reliable	Less reliable
Hard tissue interface	Resilient connection, tooth mobility up to ~0.2 mm regarded as physiological	Rigid connection, no mobility

[2] Refer to Episode 45 and 46 for more information on the immune system.
[3] Hemidesmosomes are multiprotein complexes that facilitate the adhesion of basal epithelial cells to the underlying basal lamina of the basement membrane, which is, in turn, attached to the underlying connective tissue.



Risk factors of peri-implant disease

Both mechanical and biological complications can affect clinical outcomes of dental implants. Mechanical complications can include fracture of the implant, fracture of veneer material (ceramic fracturing, chipping), abutment or screw loosening, and loss of retention. Biological complications involve inflammatory conditions, such as peri-implant mucositis and peri-implantitis. [8]

Peri-implant diseases are caused by oral bacterial biofilm, which elicits a local inflammatory response leading to the destruction of the peri-implant soft and hard tissue. [17]

Many risk factors are associated peri-implantitis development. Risk factors are either local or general. Local risk factors influence bacterial load and bacterial pathogenicity around implants. Local risk factors include specific conditions around the implant (e.g., prosthetic options, the implant system, soft tissue conditions, peri-implant microbiota). General risk factors may influence a person's susceptibility to infection (e.g., smoking, systemic conditions, etc.). Clinicians should be aware of these factors and modify where possible to reduce the incidence and progression of complications. [18]

Prosthetic options
Prosthetic options involve the prosthetic suprastructure design and ease of access to each implant for plaque biofilm removal. Prosthetic suprastructures have a variety of options for the type of retention, connection, positioning of the crown margin, and emergence profile of the prosthesis.

Ability to remove the suprastructure is beneficial for prevention and treatment of peri-implant infections. While it is possible to remove screw-retained prostheses, it is not possible for cemented prostheses, which has implications for implant care. [18]

Screw-retained reconstructions should be selected whenever there is risk of excess cement not being entirely removed. Residual cement is a risk factor for mucositis and peri-implantitis. Excess cement acts as a foreign body and induces an inflammatory reaction, leading supporting bone loss.

Every implant system has a specific design, surface texture, and connection type. These features may influence peri-implantitis development and progression. Clinicians should consider the risk of infection when selecting an implant. Shape of the prosthetic reconstruction should allow proper plaque control around the implant to avoid infection. For example, the emergence profile should avoid over-contours and should facilitate good plaque control and regular interproximal cleaning. Concave profiles should be used with caution.

Surface texture of the implant is unlikely to be important providing microorganisms do not colonize the surface. However, exposure of rough surfaces facilitates plaque retention and influences progression of peri-implant disease. [18]

Soft-tissue conditions
Soft-tissue conditions around implants include width of keratinized mucosa, height of crestal mucosa, phenotype, and presence of recession**.**

Nature of the soft tissue and presence of a minimal width of keratinized mucosa may influence peri-implant health. Nonkeratinized, mobile mucosa increases plaque accumulation, tissue inflammation, recession, and loss of attachment. Thus, a minimum width of non-mobile keratinized mucosa should be preserved.

Animal research by Imber et al. (2023) found after complete removal of keratinized tissue around implants, the newly formed soft tissue barrier was characterized by nonkeratinized epithelium typical for alveolar mucosa, whereas at tooth sites, gingiva

was spontaneously regenerated. Thus, efforts should be made to ensure the presence of keratinized mucosa when implants are placed to maintain the integrity of the implant-soft tissue seal. [19]

Presence of soft-tissue defects (e.g., scar tissue, frenulum traction) induces more plaque accumulation, tissue inflammation, attachment loss, and recession. These soft-tissue defects should be corrected (if possible) to help prevent peri-implant diseases.

Marginal mucosa stability depends on the nature of the underlying bone. For example, a bone dehiscence may increase risk of mucosal recession. Soft-tissue recession may increase risk of peri-implantitis, particularly if a rough portion of the implant surface is exposed, increasing risk of bacterial adhesion. [18]

Peri-implant microbiota
Conditions around implants may influence the load and pathogenicity of the surrounding microbiota. These conditions include peri-implant pocket depth, endodontic and periodontal status of proximal natural teeth, and type of edentulism.

Microbiota pathogenicity around implants mainly depends on pocket depth, as a greater number of bacteria and pathogenic bacteria are found at sites with deeper probing depths. Consequently, deep pockets may be a risk for disease development.

Endodontic lesions of adjacent teeth can contaminate an implant. Distance between endodontically treated teeth and an implant, as well as time between endodontic treatment and implant placement, is debated. It is recommended to maintain a minimal distance from the apex of an endodontically treated tooth and wait for healing (>4 weeks) before placing an implant next to an endodontically treated tooth. [18]

History of periodontitis
Proximity to natural teeth with periodontal lesions may result in implant contamination. Periodontal health should be optimized before implant therapy is initiated. All clients should receive oral hygiene instructions and regular periodontal care. [18]

- Several systematic reviews found a history of periodontitis increased the risk of peri-implantitis by 4.7 to 9-fold. [13]
- Individuals with a history of treated periodontitis show a statistically significant higher risk for peri-implantitis and a significantly higher risk of implant loss compared with those without periodontitis. [17] [20]
- Note: history of one or more implant failures is also a risk factor. [21]

Tobacco smoking
- Smoking, especially nicotine, impairs new bone formation, reduces calcium absorption, and contributes to transient decrease in bone mineral density.
- Tobacco smokers tend to develop peri-implantitis earlier than never-smokers. Prevalence of peri-implantitis in current-smokers is reported to be at least four times higher than never- and former smokers.

- Smokers have more than a 2-fold increased risk of losing a functionally loaded implant compared with non-smokers. Risk increases to more than 3-fold when implants are placed in augmented bone.
- Smokers with poor oral hygiene experience higher risk for progressive bone loss when compared with non-smokers with similar oral hygiene levels.
- Clients who smoke should be advised to quit smoking and receive smoking cessation counselling. [13] [14] [17]

Osteoporosis[4]
Evidence indicates effects of osteoporosis on implant therapy differs by bone type. Outcomes of implants in postmenopausal females with osteoporosis is similar to females with normal bone density. [13]

A literature review by Venkatakrishnan et al. (2017) found the success rate of dental implants in individuals with osteoporosis was comparable to individuals without osteoporosis. Further, they found implants can be placed with predictable results in individuals with osteoporosis receiving oral bisphosphonates. Discontinuation of oral bisphosphonates is not mandatory during implant placement.

Considerations for implant therapy for individuals with osteoporosis include appropriate oral self care, good oral health prior to placement, as well as proper treatment planning, assessment of the bone quality (e.g., via CBCT scan), and preparation of the implant site. The authors concluded dental implants were not contraindicated in individuals with osteoporosis. [22]

A systematic review with meta-analysis by de Medeiros et al. (2017) found implants placed in clients with osteoporosis did not present higher failure rates than those placed in clients without osteoporosis. Based on three studies included in the systematic review, implants placed in clients with osteoporosis presented greater marginal bone loss than those placed in the control group. Nonetheless, the values were within clinical parameters. Additional randomized controlled clinical studies are necessary to evaluate further. [23]

A review by Schwarz et al. (2018) found no association between osteoporosis, osteopenia, and peri-implantitis. [24]

A review by Grisa and Veitz-Keenan (2018) found implant survival rate in participants with osteoporosis was similar to the control group. The authors concluded implants placed in clients with osteoporosis did not present higher failure rates than those placed in clients without osteoporosis. [25]

A systematic review and meta-analysis by Lemos et al. (2023) found dental implants were a viable treatment option for clients with osteoporosis. However, clinical care by professionals is necessary to ensure maintenance of peri-implant bone stability, as these clients may be susceptible to increased bone loss. [26]

[4] For more information on osteoporosis refer to Episodes 41 and 42.

Diabetes
Dental implant placement is generally safe and reliable in individuals with properly controlled diabetes. Systematic reviews have concluded implants in individuals with diabetes have a high survival rate, at least within the first three years, provided good glycemic control is maintained, and also implant procedures are safe and predictable in individuals with well-controlled diabetes. [27] [28] [29]

However, systematic reviews have also indicated clinicians should evaluate HbA1c values[5] as a risk assessment for clients with diabetes before implant placement and throughout the implant's lifespan, and to consider hyperglycemia a significant risk factor associated with peri-implant inflammation. In those with poorly controlled diabetes, implant placement may have an unpredictable prognosis, delayed osseointegration, and higher risk of failure. [27] [28] [29] [30]

Medications
Many medications used to treat systemic conditions, such as nonsteroidal anti-inflammatory drugs (NSAIDS), bisphosphonates, selective serotonin reuptake inhibitors (SSRIs), and proton pump inhibitors may affect bone metabolism.

NSAIDs
Evidence from some research indicated perioperative use of NSAIDs did not impact peri-implant bone loss after implant placement. However, other research indicated perioperative use of NSAIDs may negatively affect dental implant osseointegration by an inhibitory effect of NSAIDs on bone healing. While another study demonstrated bone-sparing activity. [13] [31] [32]

Bisphosphonates
Bisphosphonates[6] are prescribed for conditions that affect the bone (osteoporosis, osteogenesis imperfecta, Paget's disease) and for malignant pathologies (malignant hypercalcemia, bone metastases, lung and breast cancer, multiple myeloma) because they prevent bone resorption. [33]

A narrative review by Ouanounou et al. (2016) analyzed effects of systemic medications, including bisphosphonates, on osseointegration. The researchers found insufficient data to suggest implant therapy should be avoided in individuals receiving bisphosphonates. Nevertheless, clinicians who place implants must to be cognizant of the risk of treating clients under oral or intravenous bisphosphonate therapy. [34]

A review by Hämmerle and Tarnow (2018) highlighted prolonged use of high doses of bisphosphonates increased the risk of bone necrosis[7] of the jaws in conjunction with implant therapy. [7]

A systematic review by Rebelo et al. (2023) analyzed the influence of bisphosphonates on dental implant osseointegration. The mean failure rate of implant osteointegration

[5] HbA1c is a blood test that measures average blood glucose levels over the past three months.
[6] Refer to Episode 41 for more information bisphosphonates and osteoporosis.
[7] Refer to Episode 42 for more information on medication-related osteonecrosis of the jaw (MRONJ).

was 50%, regardless of the generation of bisphosphonates used. Failure rate was lower in individuals using second generation bisphosphonates (e.g., alendronate, pamidronate) compared with first generation (e.g., clodronate) and third generation (e.g., risedronate, zoledronic acid). It was also lower when there was an interruption of bisphosphonate therapy when placing implants compared with continuous administration. Implant failure was higher with intravenous (IV) administration of bisphosphonates compared to oral administration. Furthermore, if individuals were smokers, had diabetes, hypertension, or poor oral hygiene, they were more prone to implant failure. More studies are needed to better understand the clinical findings associated with bisphosphonates and implant therapy. [33]

Based on expert opinion from the American Dental Association (2023), antiresorptive therapy (e.g., bisphosphonates, RANKL [receptor activator for nuclear factor-kappa B ligand] inhibitors, sclerostin inhibitors) does not appear to be a contraindication for dental implant therapy. Larger, and longer-term studies are needed to determine if implants placed in individuals exposed to antiresorptive agents perform as well as those placed in those who have not been exposed. [35]

SSRIs

SSRIs are used to treat depression and other mental health conditions. Since osteocytes, osteoblasts, and osteoclasts have serotonin receptors, SSRIs impact bone metabolism by increasing osteoclast differentiation and inhibiting osteoblast proliferation.

A cohort study by Wu et al. (2014) found treatment with SSRIs was associated with an increased failure risk of osseointegrated implants, which was attributed to the inability of the bone to remodel in response to mechanical loading. The authors suggested careful surgical treatment planning for clients on SSRI therapy. [36]

A systematic review by Chappuis et al. (2018) showed an association of SSRIs with implant failure. [37]

Proton pump inhibitors

Proton pump inhibitors are a group of drugs used to treat a variety of pathologies related to stomach acid production, such as gastroesophageal reflux disorder (GERD) and gastric ulcers. Animal studies have shown proton pump inhibitor administration can impair bone healing and implant osseointegration. Systematic reviews have showed an association of proton pump inhibitors with an increased rate of implant failure. Further studies are needed to determine the exact association. [37] [38] [39]

Alcohol

Excessive alcohol consumption has been associated with implant loss in retrospective, case-control, and animal studies. Alcohol inhibits bone remodelling and osteoclast activity, contributing to poor bone quality. Clients with problematic alcohol use should be referred for counselling and treatment to help reduce risk of peri-implant disease and improve the long-term success of implant therapy. [13] [17]

Radiotherapy
Implants placed in irradiated bone have significantly lower survival rates than normal bone, some as low as 50%. This is particularly true of implants placed in the maxilla, shorter (7-10 mm) implants, and machined surfaces (almost 3 times higher failure than surface-treated implants). Placing implants in bone within a period less than 12 months after radiotherapy significantly lowers implant survival rates by almost 3-fold. The survival is independent on the radiation dose.

The underlying cause for lower survival rates is reduced vascularity, cellularity,[8] and reparative capacity of bone. Radiation exposure does not appear to impact implants that have already osseointegrated, with some studies indicating hyperbaric oxygen treatment may improve survival of these implants. [13] [17]

Oral self-care
Poor oral hygiene was the strongest predictor of peri-implant disease in cross-sectional, retrospective, and prospective studies. Plaque control was also a predictor of peri-implant bone loss and inflammation in partially dentate or fully edentulous implant rehabilitation. Oral hygiene is especially important in association with other risk factors such as smoking. Individuals with a combination of poor oral hygiene and smoking had significantly greater mean marginal bone loss than smokers with good oral hygiene (1.5 vs 1.0 mm). [13]

Peri-implant maintenance therapy
Routine maintenance therapy plays a vital role in lowering risk of peri-implant disease. A retrospective cross-sectional study by Rokn et al. (2016) found one out of five clients without regular maintenance experienced peri-implantitis within a 5-year period. [40]

A systematic review by Monje et al. (2016) showed maintenance therapy lowered peri-implant disease risk. However, even with peri-implant maintenance therapy, biologic complications can still occur indicating the influence of local contributing factors. The authors recommended a minimal maintenance interval of five to six months. [41]

Implant failure
Despite the high success rate of dental implants, implants do fail. Failure can be classified as early or late. Early implant failure occurs as a result of unsuccessful osseointegration, while late failure occurs after successful osseointegration.

One of the major causes of late implant failure has been attributed to peri-implantitis which can progress from peri-implant mucositis if not controlled. Therefore, to ensure long-term dental implant stability, it is important to monitor and maintain peri-implant health, as well as diagnose and treat any associated disease as soon as possible. [8]

[8] Cellularity is the number of cells in a given tissue sample.

Implant failure [42]

Type	Early failures (Intraoperative or within 3 months)	Late failures (Postoperative after 3 months)
Local vs. host factors	Local factors	Host factors
	Poor implant selection: type, length, diameter Poor bone quality	Systemic factors: diabetes, osteoporosis, certain medications
	Surgical placement: off axis, lack of initial stabilization, overheating bone, minimal space between implants	Habits: smoking, parafunctional habits, alcohol use
	Restorative problems: improper design, occlusal scheme, improper fit, excessive loading, implant fractures	Radiotherapy
Human factors	Expertise of clinician placing implant	Client: inadequate post-operative maintenance (poor oral self-care, failure to attend maintenance visits)
	Laboratory technician: improper design of prosthesis	Clinicians missing early implant mucositis and not intervening promptly
Mechanical	Lack of osseointegration	Functional problems Occlusal overload Traumatic occlusion
Biological	Peri-implantitis	Peri-implantitis

Diagnosis of peri-implant conditions [6] [43]

Condition	Requirements	Other
Peri-implant health	No clinical sign of inflammation. No bleeding and suppuration on gentle probing. No increase in probing depth compared with previous examinations. No bone loss beyond crestal bone level changes resulting from initial bone remodelling.	Note: probing depths depend on the height of the soft tissue at the location of the implant. Peri-implant tissue health can exist around implants with variable levels of bone support.
Peri-implant mucositis	Bleeding and/or suppuration on gentle probing with or without increased probing depth compared with previous examinations. No bone loss beyond crestal bone level changes resulting from initial bone remodelling.	Note: visual signs of inflammation can vary and peri-implant mucositis can exist around implants with variable levels of bone support.
Peri-implantitis	Bleeding and/or suppuration on gentle probing. Increased probing depth compared with previous examinations. Bone loss beyond crestal bone level changes resulting from initial bone remodelling.	Note: visual signs of inflammation can vary and mucosal margin recession should be considered in probing depth evaluation.
	If prior examination data unavailable, diagnosis can be based on combination of: Bleeding and/or suppuration on gentle probing. Probing depths of ≥ 6 mm.	

Condition	Requirements	Other
	Bone levels ≥ 3 mm apical of the most coronal portion of the intra-osseous part of the implant.	

Diagnosing peri-implant conditions

Assessing for inflammation at an implant site involves visual inspection, peri-implant probing, digital palpation, and client discussion (e.g., have they noted changes, discomfort, loose components). Periodontal measurements are necessary to assess for bleeding and/or suppuration on gentle probing and to monitor for changes in probing depths and mucosal margin height. Implants should also be evaluated for mobility and loose components. [5]

Assessing the occlusion and contact points of dental implant restorations is also important. This should be completed at the restoration appointment, as well as at future recare visits. Occlusal assessment should include any signs of occlusal overload on the implant prosthesis and any signs of occlusal wear and mobility of the natural dentition. If occlusal overload is present, an occlusal adjustment is usually necessary and an occlusal appliance may be indicated. [8]

Clients who grind their teeth (i.e., sleep and/or awake bruxism)[9] may also require an occlusal appliance to help prevent fracture of implant retained restorations.

Contact points can be assessed by using dental floss. A lack of tight contacts can result in food impaction and subsequent caries in adjacent natural teeth, as well as gingival inflammation, peri-implant mucositis, and peri-implantitis. Even if contact points were tight when the prosthesis was fitted, teeth anterior to the implant can drift mesially, creating a gap for food impaction. [8]

<u>Peri-implant probing</u>

- Routine periodontal probing is a controversial issue due to there is some evidence probing around implants may damage the implant-soft tissue interface.[10] [44]
- Probing measurements are influenced by amount of inflammation, probing force, implant location, prosthetic contour; and by differences in shape, measurement increments, and material (e.g., plastic, stainless steel) of the periodontal probe used.
- Because plastic probes are flexible, deeper probing depths may be registered using plastic probes compared with stainless steel probes. Therefore, the same type of probe should always be used.
- Research has suggested conventional metal periodontal probes do not appear to cause any damage to either the mucosal attachment or to the implant. [45]
- Initial probing measurements should be obtained at the time of loading. If probing is not possible, the prosthetic reconstruction should be removed and adjusted.
- A light probing force (~0.25 N or 25 grams of pressure) should be used around implants to avoid trauma.

[9] Refer to Episode 82 for additional information on bruxism and tooth wear.
[10] Is peri-implant probing causing over-diagnosis and over-treatment of dental implants? https://www.mdpi.com/2077-0383/8/8/1123

- Probing depths depend on the height of soft tissues surrounding the implant and the initial implant placement (i.e., how deep the implant was placed in the bone).
- Peri-implant tissue health can exist around implants with variable levels of bone support.
- Generally, however, the probing depth associated with peri-implant health is approximately ≤5 mm. [3] [4]
- Assess probing depths with reference to the initial depths when the implants were placed following the healing process. Increasing probing depths is indicative of disease progression. [14] [43]

Bleeding on probing

- No bleeding on gentle probing indicates soft tissue health, with a low probability of disease development and progression.
- A long-term study by Renvert et al. (2018) demonstrated peri-implant health after 9-14 years was predictive of future implant health. [46]
- Bleeding on probing suggests soft tissue inflammation, and is required to diagnosis peri-implant health, peri-implant mucositis, or peri-implantitis.
- It is difficult to distinguish between biofilm-induced peri-implant inflammation and mechanically-induced trauma. Therefore, bleeding “dots” should be interpreted carefully because this bleeding may be a result of trauma and not due to tissue inflammation.
- Early detection of inflammation around an implant is vital to prevent peri-implant disease. [14] [43]

Suppuration

- Suppuration is the result of inflammation with neutrophil cell death within the soft tissues adjacent to infected implants and is a diagnostic criterion for peri-implant disease.
- Suppuration may be observed during probing or upon palpating the peri-mucosal tissues. When palpating the tissues also evaluate for discomfort. [5] [14]

Radiographic evaluation

- Long-cone parallel radiographic techniques are recommended to assess interproximal crestal bone level changes periodically.
- Intraoral radiographs are evaluated for implant bone loss beyond bone level changes from initial bone remodelling.
- Alveolar bone remodelling following the first year in function may depend on the type and position of the implant, but alveolar bone loss starting after the implant was placed in function should not exceed 2 mm.
- Bone loss ≥2 mm during or after the first year should be considered pathologic. An intraoral radiograph should be taken at baseline with the suprastructure in place that clearly identifies the implant threads and mesial and distal bone levels.
- Radiographs should be taken based on clinical judgement after implant assessment. Subsequent radiographs are compared with baseline radiographs to assess for implant bone level changes. [4] [14] [43]

Treatment of peri-implant diseases
After diagnosing peri-implant disease, many factors must be considered before creating a treatment plan. Resolving inflammation is crucial. Accordingly, treatment of both peri-implant mucositis and peri-implantitis should focus on infection control. This would include removing hard and soft deposits from the implant surface, adjusting the suprastructure if needed, and instructing the client on oral self-care. Effective biofilm control is critical for success. [43]

Treatment plan for peri-implant mucositis
The objective of peri-implant mucositis treatment is to resolve inflammation by controlling the infection and creating maintainable healthy peri-implant conditions.

- Investigate oral self-care and tobacco use if inflammation is generalized around both natural teeth and implants.
- Examine the prosthetic suprastructure for misfitting or loose components, and design flaws that prevent access for good oral hygiene.
- Provide oral hygiene instruction, smoking cessation support, and a course of mechanical therapy, as required. Regular maintenance visits should be scheduled once inflammation resolves.
- Presence of residual cement in the peri-implant pocket should be investigated if inflammation is only present around cemented restorations. Any residual cement should be removed. Surgical intervention may be necessary to remove cement if the suprastructure cannot be removed.
- Presence of retained floss should be investigated. Case reports have described peri-implantitis associated with dental floss remnants around the neck of dental implants. Exposed rough implant surfaces may tear floss fibres resulting in trapped floss remnants on rough implant surfaces, which, in turn, may lead to plaque-related peri-implant inflammation and, subsequently, bone loss. [47] [48]
- If inflammation persists following several maintenance visits, regardless of low plaque scores, referral to investigate the client's general health may be required, and the suprastructure may need to be modified or replaced. [43]

Treatment plan for peri-implantitis

- Implant removal may be necessary if the implant is determined to be unsalvageable.
- If the implant is salvageable, treatment should focus on controlling the infection. Nonsurgical therapy is the first step to allow time to evaluate the tissue healing response and the client's ability to perform effective oral self-care.
- Nonsurgical treatment in combination with good oral hygiene may be sufficient to control the infection without any further surgical intervention. [43]

Nonsurgical therapy

- Standard treatment for peri-implant mucositis is conventional nonsurgical mechanical therapy combined with oral self-care reinforcement, which results in an average of 0.5-1.0 mm pocket depth reduction and 15-40% reduction in bleeding on probing.

- Nonsurgical treatment of peri-implantitis (e.g., mechanical debridement alone) usually reduces inflammation. However, complete resolution of the disease is unlikely in advanced cases.
- Power-driven air-polishing devices,[11] titanium curettes, and ultrasonic scalers with a disposable plastic sleeve can be used to clean titanium implants. Be aware that plastic debris could be left behind from the plastic sleeve if used on exposed rough implant surface. Note: use a dedicated sharpening stone for implant scalers that can be sharpened to theoretically prevent cross contamination with stainless steel filing imbedded in sharpening stones.
- For both titanium and ceramic implant systems[12] follow the implant manufacturer's instruction for appropriate care and maintenance. For example, Straumann® recommends teflon-based hand scalers and curettes only for their ceramic implants. Metal instruments (e.g., ultrasonic or hand scalers) are not recommended for debridement of ceramic implants because metallic abrasion may occur on the implant surface. Avoid applying ultrasound through metallic transmitters on ceramic implants since the surface can be damaged permanently by incorrect use and application of ultrasound. Do not use abrasive prophylaxis pastes, and powder/water jet cleaners many not be suitable for ceramic implants. [49]
- Additional use of adjunctive therapies (e.g., antiseptic, antibiotic, antimicrobial, laser-assisted[13] and probiotic[14] therapies) provides only minimal clinical improvements in bleeding tendency and pocket reduction. When fixed implant-supported restorations hinder proper diagnosis or oral self-care, the restoration must be removed or recontoured.
- Clinicians are advised to remove the superstructure to obtain access for cleaning and to modify the prosthesis if needed when nonsurgical treatment of peri-implant disease has failed to resolve the infection.
- Place the client on a supportive maintenance program if the condition is resolved by nonsurgical therapy.
- Surgical therapy should be considered if signs of disease remain following initial nonsurgical treatment. [43]

Note: clinical and radiographic features of oral squamous cell carcinoma (OSCC)[15] could be misdiagnosed as peri-implantitis. Accordingly, OSCC should be considered in persistent lesions surrounding dental implants. [50]

Surgical therapy

- Surgical therapy may be necessary to access to the implant surface for mechanical debridement and chemical decontamination.
- Surgical approaches usually include access surgery, resective surgery, or a regenerative procedure.

[11] Refer to Episode 35 for more information on air polishing implant surfaces, including types of air polishing powders safe for implants.
[12] Refer to Episode 18 for more information on ceramic (zirconia) implants.
[13] Refer to Episode 24 for discussion on laser-assisted therapy in the treatment of periodontitis and peri-implant diseases.
[14] Refer to Episode 63 for more information on probiotics and peri-implant disease.
[15] Refer to Episodes 76, 77, and 78 for additional information on oral cancer.

- The approach depends mostly on the type of defect and the position of the implant in the oral cavity.
- Mechanical and chemical decontamination of the exposed implant surface (with or without bone recontouring) is vital to create a healthy environment conducive to healing.
- Regenerative treatment can be implemented if the bone morphology can support grafting material.
- Regenerative therapy is often not advisable for clients who smoke or have poorly controlled diabetes.
- Maintenance care is critical. Susceptible individuals should be examined regularly and receive appropriate supportive treatment. It has been demonstrated that when good oral self-care is maintained following treatment, existing defects can be maintained over time. [43]

Maintenance care

Professionally administered implant maintenance therapy is effective in long-term peri-implant maintenance. Client compliance with maintenance therapy is essential for long-term prevention of peri-implant mucositis and peri-implantitis. Peri-implant maintenance intervals should be set based on the client's risk factors, homecare compliance, and prosthetic design. A recare interval of 6 months or less is recommended.

A maintenance visit should include:

- Peri-implant assessment and probing (if warranted), noting any bleeding on probing and/or suppuration.
- Radiographic examination if warranted.
- Oral self-care assessment (biofilm accumulation) and client education on biofilm control.
- Mechanical instrumentation of implant sites to remove biofilm. [43]

Home care procedures

- Both manual and powered toothbrushes are useful to improve and maintain peri-implant soft tissue health. Toothbrush type is based on the client's ability, compliance, and preference.
- Both interdental brushes and dental floss have shown to be effective in maintaining peri-implant health. Wires in interdental brushes should have plastic coating to avoid scratching the implant. Caution should be exercised with dental floss if rough implant surfaces are exposed.
- Other interproximal cleaning methods may include soft picks, rubber tip stimulators, air flossers, and/or water flossers.
- Based on current evidence, antiseptic mouthrinse or gel use has not been shown to have additional beneficial effects in the long term. [43] [51]

Take home messages

- When implant treatment is considered, an individual risk assessment should be performed as part of treatment planning. Clients should be informed of the risks for biologic complications and the need for preventive care.

- Strong risk factors for peri-implant diseases are poor oral self-care, lack of compliance with maintenance therapy, and smoking, as well as a history of periodontitis and untreated periodontitis.
- Implant complications can be reduced with adherence to a strict homecare regimen, and regular supportive maintenance appointments of no less than twice yearly.
- Clients who smoke should be offered smoking cessation.
- Clients with a history of periodontal disease should be informed of their increased risk to develop peri-implant diseases. Successful periodontal treatment should be performed before implant placement to eliminate local niches and achieve periodontal health before implant insertion.
- Dental implants should be monitored regularly.
- Standard treatment for peri-implantitis is the combination of nonsurgical mechanical therapy and good oral self-care. Failure to resolve peri-implant inflammation should result in immediate referral for diagnosis and management.
- Nonsurgical treatment of peri-implantitis usually provides clinical improvements, but may not be sufficient to treat advanced cases.
- If the condition is resolved by nonsurgical therapy, the client can be placed on a supportive maintenance program.
- If disease remains after nonsurgical therapy, surgical interventions should be considered, including referral to a periodontist. [12] [17] [18] [43] [52] [53]

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