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# Dental Implants- Classification, Success and Failure –An Overview

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## I. Introduction

The more teeth a patient is missing, the more challenging this task becomes. As a result of continued research, diagnostic tools, treatment planning, implant designs; materials, and techniques, predictable success is now a reality for the rehabilitation of many challenging clinical situations.[1] Outcome assessment in any clinical discipline is generally compromised by the inadequacies of study design, poor record keeping, biased reviewers and multiple uncontrolled variables that substantially diminish the validity of clinical investigations. Implant treatment has a high success rate that has been rated as high as 95 to 99%,[2]despite high success rate with endosseous titanium implants, failures unavoidably occur. At early stage, lack of primary stability, surgical trauma, peri operative contamination and occlusal overload seem to be the most important causes of implant failure.[3] The microbiological component plays an important role in encouraging and facilitating implant infection during implant placement, and also later when the implant is in function in the mouth, which is a septic medium.[4] The latter also involves an infectious component that is encouraged by microfractures in the bone and the appearance of peri-implant pockets, with a clear infectious component.[5] We should neither fear nor embrace failure. Pursuing with all vigour, the factors influencing implant failure will in long term contribute significantly to improve oral health.

there are 3 basic types of dental implants-

- Eposteal dental implant
- Endosteal dental implant
- Transosteal dental implant

**Classification of Implants**

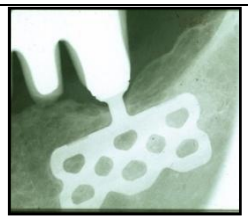
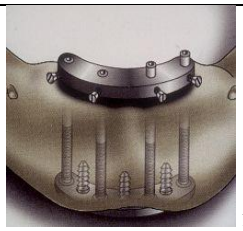
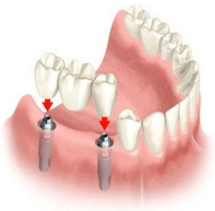
Dental implants may be classified under four categories: [8]

A - Depending on the placement within the tissues
B - Depending on the materials used
C - Depending on their reaction with bone
D - Depending on the treatment options

**A - Depending On The Placement Within The Tissues -**

Depending on the placement within the tissues, implants can be classified into –

| | | |
|---|---|---|
| Endosseous | 1 - Root Form |  figure-1 |

| | | |
|---|---|---|
| | 2 - Blade (Plate) Form |  figure-2 |
| | 3 - Ramus Frame |  figure-3 |
| Subperiosteal | 1 – Unilateral |  figure-4 |
| | 2 – Complete |  figure-5 |
| | 3 – Circumferential |  figure-6 |
| Transosteal | 1 – Staple |  figure-7 |
| | 2 - Single Pin |  figure-8 |
| | 3 - Multiple Pin |  figure-9 |

**B - Depending On The Materials Used –**
Based on the marerials used, the implants can be classified into –
**Metallic implants –** Titanium, Titanium alloy, Cobalt Chromium Molybednum alloy.
Non- metallic implants – Ceramics, Carbon etc.

**C - Depending On Their Reaction With Bone –**
Based on the ability of the implant to stimulate bone formation, implants can be classified into –
Bioactive implants – Hydroxyapatite
Bio-inert implants – metals

**D - Depending On The Treatment Options –**
Misch in 1989 reported five prosthetic options of implants, of the five the first three are fixed prosthesis that may be partial or complete replacements, which in turn may be cemented or screw retained. The fixed prosthesis are classified based on the amount of hard and soft tissue structures that are to be replaced. The remaining two are removable prosthesis that are classified based on the support derived.
**FP- 1:** Fixed prosthesis; replaces only the crown; looks like a natural tooth.
**FP- 2:** Fixed prosthesis; replaces the crown and a portion of the root; crown contour appears normal in the occlusal half but is elongated or hypercontoured in the gingival half.
**FP- 3:** Fixed prosthesis; replaces missing crowns and gingival color and portion of the edentulous site; prosthesis most often uses denture teeth and acrylic gingival, but may be made of porcelain, or metal.
**RP-4:** Removable prosthesis; overdenture supported completely by implant.
**RP-5:** Removable prosthesis; overdenture supported by both soft tissue and implant.

**Success Criteria For Dental Implants**
**Smith and Zarb**have reviewed the success criteria given by different authors.[7]

**A - Schnitman And Schulman :**
1. Mobility less than 1 mm in any direction.
2. Radiologically observed radiolucency graded but no success criterion defined.
3. Bone loss not greater than one third of the vertical height of the bone.
4. Gingival inflammation amenable to treatment.
5. Functional service for 5 years in 75% of patients.

**B - Chainin, Silver Branch, Sher, And Salter :**
1. In place for 60 months or more.
2. Lack of significant evidence of cervical saucerization on radiographs.
3. Freedom from hemorrhage according to Muhelman's index.
4. Lack of mobility.
5. Absence of pain and tenderness.
6. No pericervicalgranulomatosis or gingival hyperplasia
7. No evidence of a widening peri-implant space on radiograph.

**C - Mckinney, Koth, AndSteflik:**
Subjective Criteria -
i. Adequate function.
ii. Absence of discomfort.
iii. Patient belief that esthetics, emotional, and psychological attitude are improved.

**Objective Criteria -**
i. Good occlusal balance and vertical dimension.
ii. Bone loss no greater than one third of the vertical height of the implant, absence of symptoms and functionally stable after 5 years.
iii. Gingival inflammation vulnerable to treatment.
iv. Mobility of less than 1 mm buccolingually, mesiodistally, and vertically.
v. Absence of symptoms and infection associated with the dental implant.
vi. Absence of damage to adjacent tooth or teeth and their supporting structures.
vii. Absence of parasthesia or violation of mandibular canal, maxillary sinus, or floor of nasal passage.
viii. Healthy collagenous tissue without polymorphonuclear infiltration.

**Success Criteria**
Provides functional service for 5 years in 75% of implant patients.

## II. Revised Criteria For Implant Success

**Alberktson, Zarb, Washington, And Erickson -**

i. Individual unattached implant that is immobile when tested clinically.
ii. Radiograph that does not demonstrate evidence of peri-implant radiolucency.
iii. Bone loss that is less than 0.2 mm annually after the implant's first year of service.
iv. Individual implant performance that is characterized by an absence of persistent and/or irreversible signs and symptoms of pain, infections, necropathies, paraesthesia, or violation of the mandibular canal.

In content of criteria mentioned, a success rate of 85% at the end of a 5-year observation period and 80% at the end of 10-year observation as a minimum criterion for success.[7]

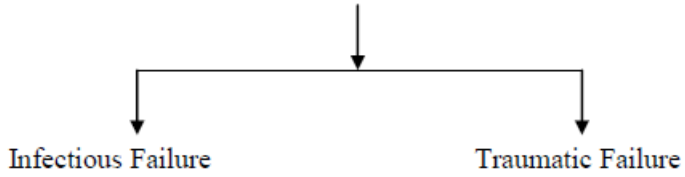
Further, in 1998 **Esposito et al.**[7,9] have listed out the various criteria for success which were agreed upon at the 1st European Workshop on Periodontology. According to them following were to be considered success criteria for osseointegrated implants –

- Absence of mobility
- An average radiographic marginal bone loss of less than 1.5 mm during the first year of function
- Less than 0.2 mm annually thereafter,
- Absence of pain/parasthesia

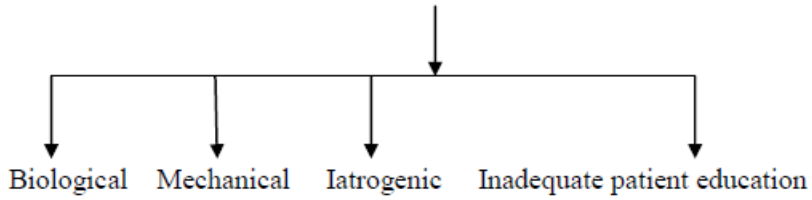
It was also suggested that probing depths related to a fixed reference point and bleeding on probing should be measured. Several authors have expressed many criteria to assess the success of a functional implant. The success criteria, which were initially targeted for evaluation as 5 years survival has changed. With the improved technology and understanding of the tissue behaviour the criteria are set with a target of 10-year survival rate.[7,9]

**Implant Failures**

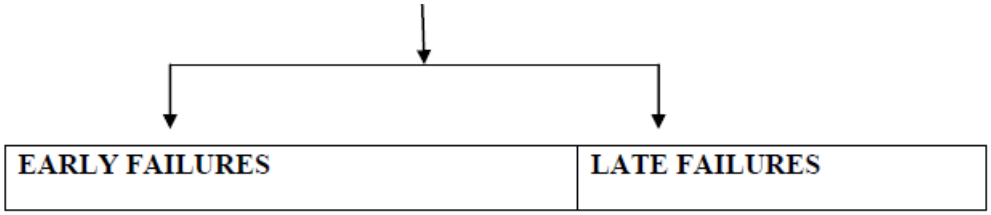
**I. Rosenberg et al.**[7] classified implant failures as:




**II. Esposito et al** [7,9]classified implants according to the Osseointegration Concept:




**I. Truhlar**[7] classified failures as :



**II. Hobo et al.**[7] listed out the various complications occurring in implants as follows:

| | |
|---|---|
| 1- Loss of bone anchorage<br>a) Mucoperiosteal perforation<br>b) Surgical trauma | 1- Complications in stage I surgery<br>• Mental nerve damage<br>• Penetration into a sinus, nasal cavity, or through inferior border of the mandible.<br>• Excess countersink<br>• Thread exposure<br>• Eccentric drills, taps<br>• Stripping of threads<br>• Jaw fracture<br>• Ecchymosis, more common in older patients<br>• Wound dehiscence<br>• Facial space abscess submental, submandibular, ludwig's angina<br>• Suture abscess<br>• Loose cover recovery |
| 2 - Gingival problems,<br>a) Proliferative gingivitis<br>b) Fistula formation | 2 – Complications in Stage II surgery<br>• Poor selection of fixture height<br>• Incorrect fixture placement more than $35^0$ cannot be used prosthetically<br>• Damaged hex nut on top of fixture<br>• Loose abutment<br>• Fractured abutment screw,<br>• Early loading by prostheses<br>• Poor air-flow pattern with " high- water" design<br>• Aspiration of instruments<br>• Thread exposure<br>• Fixture fractures<br>• Excess bone resorption<br>• Plaque/calculus formation, periodontal problems<br>• Poor selection of abutment height |

| 3 – Mechanical complications | 3 – Prosthetic complications |
|---|---|
| a) Fracture of prosthesis, gold screw, abutment screw | • Insufficient space beneath the fully bone anchored prosthesis |
| | • Abutment penetrate through alveolar mucosa |
| | • Screw fractures: gold or abutment screws |
| | • Acrylic or porcelain fracture |
| | • Posterior fixture failures in the maxilla |

**III. El askary et al**. [7] have divided the FAILURES into seven categories –

| | | |
|---|---|---|
| **1** | **According to etiology** | **Failures because of host factors**<br>Medical status - Osteoporosis and other bone diseases; uncontrolled diabetes.<br>Habits - smoking, para-functional habits.<br>Oral status - poor home care, juvenile, and rapidly progressive periodontitis, irradiation therapy. |
| | **A) Restorative problems** | Excessive cantilever, pier abutments, no passive fit, improper fit of the abutment, improper prosthetic design, improper occlusal scheme, bending moments, connecting implants to natural dentition, premature loading, excessivetorquing. |
| | **B) Surgical placement** | Off axis placement (severe angulation)<br>Lack of initial stabilization<br>Impaired healing and infection because of improper flap design or others.<br>Overheating the bone and exerting too much pressure.<br>Minimal space between implants<br>Placing the implant in immature bone grafted sites.<br>Placement of the implant in an infected socket or a pathologic lesion.<br>Contamination of the implant body before insertion. |
| | **C) Implant selection** | Improper implant type in improper bone type.<br>Length of the implant (too short, crown-implant ratio unfavourable)<br>Diameter of the implant. |
| **2** | **According to origin of infection –** | Peri-implantitis (infective process, bacterial origin)<br>Retrograde peri-implantitis (traumatic occlusion origin, non-infective, forces off the long axis, premature, or excessive loading). |
| **3** | **According to timing of failure –** | Before stage II (after surgery)<br>At stage II (With healing head and or abutment insertion)<br>After restoration. |
| **4** | **According to condition of failure (clinical and radiographic status)** | Ailing implants<br>Failing implants<br>Failed implants<br>Surviving implants |
| **5** | **According to responsible personnel –** | Dentist (oral surgeon, prosthodontist, periodontist)<br>Dental hygienist<br>Laboratory technician<br>Patient. |
| **6** | **According to failure mode -** | Lack of osseointegration (usually mobility)<br>Unacceptable esthetics<br>Functional problems<br>Psychological problems. |
| **7** | **According to supporting tissue type –** | Soft tissue problems (lack of keratinized tissues, inflammation, etc.)<br>Bone loss (Radiographic changes, etc.)<br>Both soft tissue and bone loss. |

**IV.** According **to Cranin**

**1) Intraoperative complications**

| Endosteal Implants | Subperiosteal Implants |
|---|---|
| - Oversized osteotomy<br>- Perforation of cortical plates<br>- Fracture of cortical plates<br>- Inadequate soft tissue flaps for implants coverage<br>- Broken burs<br>- Hemorrhage<br>- Poor angulations or position of an implant<br>- Injury to the mandiblular neurovascular bundle | - Loss of anesthesia<br>- Inability to make an accurate impression<br>- Inability to remove an impression or to seat a tray for full upper or full lower subperiosteal implants.<br>- Antral perforation.<br>- Inaccurate adaptation of full or unilateral subperiosteal implants.<br>- Inaccurate adaptation of tripodal subperiosteal implants.<br>- Injury to the infraorbital or mental nerve. |

**2) Short term complications (first 6 postoperative months)**

| Endosteal implants | Subperiosteal implants |
|---|---|
| - Post operative infection<br>- Dysesthesia<br>- Dehiscent wounds<br>- Dehiscent implants<br>- Radiolucencies<br>- Antral complications<br>- Implant mobility<br>- Post surgical scar contracture<br>- Pterygomandibular raphe<br>- Anterior vestibule | - Strut exposure<br>- post operative infection<br>- Scar contracture<br>- Pterygomandibular raphe<br>- Anterior Mandibular vestibule |

**3) Long term complications:**

| Endosteal implants. | Subperiosteal implants |
|---|---|
| - Ailing, failing or failed implants.<br>- Acitisite<br>- Prosthetic complications:<br>Fractured root form implants<br>Implants of improper angulations<br>Broken prosthesis inserts<br>Screw problem<br>Partial loosening of cemented bars or prosthesis<br>Inaccurate fit of castings<br>Fracture of blade abutments | - Bone resorption<br>- Strut dehiscence<br>- Recurrent pericrevical granulomas<br>- Broken abutments<br>- Post subperiosteal sublingual floor elevation |

## V. Implant Failure Due To

### i) Systemic Factors

Potential medical risks (**Matukas**1988):

1. Cardiovascular – Heart failure, CHD, hypertension, unexplained arythmea.
2. Respiratory – COPD, chronic obstructive pulmonary disease, Asthma.
3. GIT– Nutritional disorders, Hepatitis malabsorption, inflammatory bowel disease.
4. Genitourinary – Chronic renal failure.
5. Endocrine – Diabetes, thyroid disease, pituitary/adrenal disease.
6. Musculoskeletal, arthritis, osteoporosis.
7. Neurologic – Stroke, Palsy.

**Absolute Medical Contraindications:**

- Pregnancy
- Granulocytopenia
- Steroid use
- Continuous antibiotic coverage
- Brittle diabetes
- Haemophelia
- Ehler-Dahnlos syndrome
- Marfan's syndrome
- Osteoradionecrosis
- Renal failure
- Organ transplants
- Anticoagulant therapy
- Fibrous dysplasia
- Crohn's Disease

### ii) Psychological Factors:

- Lack of support
- Cognitive difficulty
- Mental retardation
- Dementia
- Psychosis
- Emotional problems
- Interpersonal problems

- Behavioral problems
- Problematic attitudes and beliefs.

**Basic Recommendations:-**

- Identify patient with significant psychiatric disturbance
- Refer to psychologist, if found disturbed
- Be sensitive to patient
- Maintain good communication

"Meet the mind of the patient, before you meet the mouth of the patient".

## III. Review Of Literature

1. Shafer DM, Rogerson K, Norton L and Bennett J (1995) [10]did a study to evaluate the effect of LADC (Low amperage direct current ) on the osseointegration of endosseous titanium dental implants. And they conclude that LADC does not positively affect the healing of bone.
2. Teixeira E, Wadamoto M, Akagawa Y and Kimoto T (1997) [11]investigated the applicability of short hydroxylapatite-coated dental implants to the posterior mandible of partially edentulous patients. They found that the overall cumulative survival rate was 94% for implants, and 91% for prostheses, and the results were suggested predictable success for application of short implants to the posterior mandible.
3. Mori H, Mamabe M, Kurachi Y and Nagumo AM (1997)[12] investigated the reaction of the bone-implant interface in the experimental animal models. Results suggested that osteoporotic bone may affect the healing period of bone tissue after the insertion of dental implants, but that osseointegration of dental implants may be obtained even in osteoporotic bone.
4. Mollersten L, Lockowandt and Linden L (1997)[13] did a study to evaluate the influence of joint design, strength and failure mode of dental implant systems. They conclude that **a**. Deep joints favored structure strength of implant systems. **b.** Large differences were observed in structure strength among currently used implant systems. **c**. Failure occurred mostly in the crown/abutment joint because of a broken crown screw or broken cement (in case of cemented crown) in combination with bent or fractured abutment. Less frequently, failure occurred in the abutment implant joint, which depended on failed abutment screw.

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