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Review Article

# PROSTHODONTIC FAILURES IN IMPLANTOLOGY: A REVIEW

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**ABSTRACT**

Although the dental implant is the most chosen treatment modality of the modern dentistry, the complications of the same go hand in hand. Many failures have been reported with dental implants which are caused by either surgical or prosthetic procedures. This article mainly focuses the prosthodontic failures encountered in implantology.



## INTRODUCTION

Dental implants have been used to rehabilitate edentulous patients for past over 30 years. The use of dental implants has enabled the fabrication of highly functional and esthetic restorations and improved the predictability of treatment. According to various systematic reviews the success rates of dental implants is about 85-90%. The dental implant is a foreign structure that the physiologic system of the body has to accept. Though made of a material with properties close to the body tissues, the implant is yet different and is definitely susceptible to the various biological and mechanical problems.so however, at any point during rehabilitation and maintenance, complications and failure of implants can occur. This review focuses on failures of implants from prosthetic point of view it also discusses about incidence, causes and management of the same.

***Definition of implant failures***

- "Implant failure is the first instance at which the performance of the implant, measured in some quantitative way falls below a specified and acceptable Level". Adell *et al* 1981[1]
- "Implant failure is defined as the total failure of theimplant to fulfill its purpose (functional, esthetic or phonetic) because of mechanical or biological reasons". Alberktsson *et al* 1986 [2]
- "Implant failure is the inadequacy of the host tissue to establish or to maintain ossiointegration". Alsaadi *et al* 2006 [3]

***Terminologies***

- **Ailing implants** are those showing radiographic bone loss without inflammatory signs or mobility.
- **Failing implants** are characterized by progressive bone loss, signs of inflammation, and no mobility. These implants are usually in a reversible state (ie., the condition can be treated).
- **Failed implants** are those with progressive bone loss with clinical mobility and that are not functioning in the intended sense.

***Parameters for implant failures:*** Esposito *et al* in 1998 gave following parameters for evaluating failing and failed implants [4]:

***Parameters Used For Evaluating Failed***

A) Clinical signs of early infection
B) Pain or Sensitivity
C) Clinical discernible mobility
D) Radiographic signs of failure
E) Dull sound at Percussion

***Parameters used for evaluating failing implants***

A. Radiographically observed progressive marginal bone loss.
B. Clinical signs of late infection
C. Bleeding on probing (BOP)

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D. Absence of Keratinized mucosa
E. Sulcus bleeding index (SBI)
F. Pocket probing depth (PPD)
G. Mucosal recession (REC)
H. Probing ‘‘attachment’’ levels (PAL)
I. Crevicular fluid analysis

***Dental implant failures***

Dental implant failures may be surgical or prosthodontics.

***Surgical failures***

Surgical failures are a result of various complications during surgical implant placement such as, excessive bleeding, prolong paraesthesia, overheating of bone during osteotomy preparation, nerve damage etc.

***Causes of surgical failures:*** Off-axis placement, Lack of primary stability, Infection or improper healing due to inadequate flap closure and design, overheating of bone, placement of implant in immature bone, contamination of implant body before insertion, failure to maintain aseptic conditions and underlying pathology in bone or implant site.

***Management :*** to avoid surgical failures all aseptic precautions should be taken, proper flap design, proper irrigation during osteotomy and primary stability should be achieved. In case of pathologic lesions of bone thorough debridement should preclude the placement of implants.

***Prosthodontic failures***

Prosthodontics failures of implants can be broadly classified as biological failures, mechanical failures and esthetic failures. (table 1)

**Table 1** Prosthetic Failures Of Dental Implants

| Prosthodontic failures | |
|---|---|
| Biological failures | Peri-implant mucositis,<br>peri-implantitis,<br>bone loss,<br>soft tissue hyperplasia,<br>fistulae<br>implant loss |
| Mechanical failures | Abutment Screw loosening and fracture,<br>chipping or fracture of veneering ceramic,<br>fracture of framework of restoration,<br>loss of retention and decementation,<br>abutment fracture<br>fixture fracture |
| Esthetic failures | Missing interdental papillae,<br>mucosal recession,<br>malpositioned implant<br>poor restoration contour<br>shade mismatch |

***Biological failures***

Biological failures are a result of disturbances in function of peri implant tissues such as supporting bone and soft tissues. These include following

***Peri-implant mucositis* (figure 1)**

It is an inflammatory condition affecting soft tissue surrounding the dental implants[8]. It is a reversible process and is reported to have incidence of 45-50%.

***Cause :*** lack of proper oral hygiene procedure.

***Features :*** inflamed soft tissues, bleeding on probing, Pus formation, gingival cuffing and Pocket depth 4-5mm.

***Management :*** maintenance of oral hygiene along with antiseptic mouth rinses and regular follow ups.

**Fig 1** Peri-implant mucositis with 21

***Peri-implantitis: (Figure 2)***

It is an inflammatory condition affecting bone as well as soft tissues around the implants. It is irreversible in nature and the bone loss is beyond physiologic limit of repair.

***Causes:*** lack of proper oral hygiene procedure and underlying periodontal disease. Other risk factors include diabetes mellitus, bruxism, smoking, osteoporosis, history of radiation therapy and genetics.

***Features:*** Pain, mobility of implant, bleeding on probing, boneloss, exudation, recession, exposure of implant threads, pocket depths of 4-6mm.

***Management:*** treatment includes local and systemic methods and surgery is required in few cases. Local treatment such as mechanical debridement, subgingival irrigation using antiseptic solution like chlorhexidine can be done. Local drug delivery can also be performed. Systemic antibiotic therapy is indicated in cases of severe infections surgical treatment involves raising of flap and debridement using plastic scalers or titanium tipped instrument to prevent damage to the implant body. Lasers can also be used for surgical debridement .[9, 10]

**Fig 2** Peri-implantitis with 21

***Bone loss:(Figure 3)***

Implant health and stability is dependent on level of the crestal bone. *Alberktson et al* [2] have suggested using, less than 1.5 mm of marginal bone loss during the 1st year of loading

and thereafter less than 0.2mm yearly as success criteria. This concept was probably developed from the radiographic findings on the mean marginal bone loss around Branemark implants.

***Causes of boneloss:*** excessive overloading of implant, peri-implant disease in which crevicular sulcus becomes contaminated with bacteria and causes boneloss, non axial loads, vertical canteliver and bruxism etc.

***Features :*** saucer shaped bone loss around implants evident radiographically, if more than 2/3 of bone loss along the length of implant is observed then its sign of implant failure, Perifixuralradioluscency along the length of implantAround the apical third.

***Management:*** to prevent bonelossocclusal loading should be minimal, cantilever should not be loaded with heavy contacts and there should be no contacts in excursions, prevention of peri-implant destruction by maintening good oral hygiene. [11]

**Fig 3** peri-implant bone loss around dental implants

***Soft tissue hyperplasia:(Figure 4)***

Incidence of 15-20% is reported over a period of 9 yrs. A progressive marginal infection due to poor oral hygiene can lead to implant failure. However, clinical signs of infection such as hyperplastic soft tissues, suppuration, swelling, fistulation, color changes of the marginal peri-implant tissues, etc., are signs which call for intervention.[12]

***Causes:*** lack of attached gingiva, poor fit of framework of restoration, dead space beneath framework .

***Management :*** removal of underlying cause, debridement, oral prophylaxis and regular follow up.

**Fig. 4** Hyperplasia of the peri-implant soft tissues associated with the distal aspect of an ill-fitting lower implant retained bridge

***Fistulae: (Figure 5)***

Only 1-2% cases of the fistulae have been reported at the interface between the dental implant and abutment. Fistulae are more common in cement-retained implant restorations.

***Causes:*** for fistulae include loosening of abutment screw, poor fit of the framework and prosthesis.

***Management:*** Fistulae should be treated with 0.2% chlorhexidinegluconate solution. An adequate amount of torque should be applied while placing the prosthesis. In case of ill-fitting prosthesis, restoration with a new prosthesis should be considered.[13]

**Fig. 5** Fistula associated with a loose abutment screw

***Mechanical failures***

Mechanical failures are caused when the capacity of the restoration to withstand forces exceeds. It also depends on magnitude and direction of the applied force. Implant supported prosthesis are susceptible to mechanical complications because of lack of proprioception provided by periodontal ligament as in natural teeth. Causes of mechanical failures include excess loading associated with non axial loading, cantilevers, parafunction and increased implant abutment ratio. Mechanical failures have also ben associated with the inappropriate selection or use of materials manufacturing imperfection, ill fitting frameworks and trauma.

***Prevention:*** In partially edentulous patients implant supported prostheses should be designed so that they allow light occlusal contact in the intercuspal position. This allows for compression of the periodontal ligament of adjacent teeth during function and reduces excessive occlusal loading on the implants.[14] Furthermore, wherever possible, occlusal forces should be directed axially, occlusal tables should be narrow with shallow cuspal inclines, cantilevers should be minimised and eccentric excursions should be guided by natural teeth.[14-17] Following treatment, hard nocturnal splints have been advocated to reduce the incidence of mechanical complications.[15] However, these are only likely to be effective if patient compliance is good. Frameworks should be constructed from appropriate materials, be of adequate thickness and designed appropriately to support the veneering material which may be porcelain, acrylic or composite resin.
Following mechanical failures are encountered with implant prosthesis.

***Abutment Screw loosening and fracture: (figure 6)***

Screw loosening is the most common mechanical complication as stated in various systematic reviews. It is most commonly associated with single implant restoration with incidence of 59.6% in 15yrs.

***Factors Causing screw loosening are***

- Application of inadequate amount of torque
- Poor fit of the restoration/prosthesis
- Lack of antirotation characteristics /screw design associated with implant components
- Excessive loading of the implant

It has been reported that the incidence of screw loosening is most commonly associated with the external-hex type of the implant system. External connection (EC) has shown incidence of 18.3% in 5.3 yrs, whereas Internal connection (IC) has shown 2.7% in 4.5 yrs. Incidence seemed to be reduced by use of gold alloy screws if tightened properly. In cement retained incidence: 3.1% in 5.1 yr, Cement retained with EC: 21% and Screw retained with EC : 13%. [18]

***Management:*** Screw loosening can be minimized by using torque twice at 5-6-minute interval, shallow cuspal inclinations, reducing the amount of adverse occlusal forces. Internal connection implant system should be preferred over the external hex connection type of implant system.

Fracture of the implant abutment and prosthesis screw may occur as a consequence of repeated screw loosening due to the metal fatigue. The Incidence is 0.5% in 4.4 yrs. The prime causes for the screw fracture Improper implant components, reusing the loosened screw, excessive load, ill-fitting prosthesis.

***Management:*** Fracture of the screw components can be better managed by its prevention. Proper treatment planning for the positioning and number of implants should be done. The number of the dental implants should be decided with caution so that occlusal loading is minimized. The prosthesis should be checked for fit and design. The prosthesis should align along the axial forces and oblique forces should be avoided. The patient should be advised to follow post-operative instructions and periodic checkup. If the screw gets fractured it should be retrieved. A fractured abutment screw can be retrieved using hemostat, self-made screw driver, special retrieval kit provided by specific implant systems. Hemostat can be used if the fractured segment is seen above the surface of the implant.[18,19,20]

**Fig 6** Abutment screw fracture

***Chipping or fracture of veneering ceramic:( Figure 7)***

Chipping and fracture of the veneering ceramic restoration is most commonly observed in partial fixed implant-supported prostheses whereas it is the second most common mechanical complication reported in metal and metal- ceramic single implant restorations. Incidence is higher in ceramic 8.3% than in metal ceramic 2.3%. It is more common in posterior (3.1%) than anterior (1.7%). External connection has incidence 5.4% and internal connection has 2.9%. Cement retained prosthesis showed greater incidence of fracture of veneering ceramic (3.4%) than screw retained (0.6%). Sailer and colleagues found that chipping of the veneering ceramic tended to occur more frequently with screw-retained restorations.[18,21.]

***Management:*** In order to reduce the incidence of the fracture of the veneering ceramic or the crown, it is recommended: to reduce the size of the occlusal table,

1. create shallow cusp height,
2. lighten the occlusal contacts,
3. provide uniform thickness
4. appropriate support for the veneering ceramic

**Fig 7** Fracture of veneering ceramic

***Fracture of framework of restoration: (Figure 8)***

Zarb and Jansson (1985) noted that implant frameworks were vulnerable to fracture, especially at the junctions between distal abutments and cantilevered segments. Zarb and Schmitt (1990) [22, 23] reported clinical problems that included abutment screw fracture, gold alloy retaining screw fracture, and framework fractures. Relative to framework fracture, Zarb and Schmitt suggested design changes that included cantilevered segments not exceeding 20 mm, increased cross-sectional surface areas, and using casting alloys with higher yield and tensile strengths compared to the alloys used in original osseointegrated prostheses. They also stated that prosthodontic treatment included a series of clinical steps that were mostly empirical and that treatment invariably was accompanied by varying degrees of problems. In a 5-year clinical study, Hjalmarsson *et al*. (2011)[24] reported on the clinical outcomes associated with screw-retained fixed implant prostheses made with laser welding versus frameworks made with milled commercially pure (cp) titanium. They noted significantly more complications in the laser-welded framework group compared to the milled framework group (Hjalmarsson *et al*. 2011). Ortorp and Jemt (2012)[25] reported the results of a 10-year clinical study and noted that the frequency of prosthetic complications was low, with similar clinical and radiographic results for CAD CAM

milled and cast gold alloy frameworks. One prosthesis was lost in each group due to loss of implants; one prosthesis fractured in the CADCAM milled group. They noted more maintenance appointments were needed for maxillary prostheses.

**Fig 8** Fracture of metal framework of implant supported prosthesis

***Loss of retention and decementation: (figure 9)***

Loss of retention is a complication specific to cement retained prosthesis. Loss of retention is commonly associated with abutments that provide inadequate retention or resistance form. This usually reflects incorrect abutment selection, poor abutment design or a lack of restorative space. The amount of restorative space should be assessed before implant placement. When restorative space is limited, provided bone volume is adequate, consideration should be given to deeper placement of the implant. De-bonding of single implant restoration has incidence 6.1%. The cement used has great influence on bonding of restoration, GIC had negligible incidence and Resin reinforced cement is recommended to reduce chance of decementation.[26]

**Fig 9** Decemented crown. Custom abutment has excessive axial taper

***Abutment fracture- ( figure 10, 11)***

Abutment fracture is a rare complication associated with the dental implants. In a 5 year study, only 0.5% cases were reported with the implant abutment fracture. To prevent implant abutment fracture following factors should be considered:

- Abutment should have adequate mechanical strength to resist occlusal forces and metal fatigue
- It should have a well fitting surface with the other components.
- In case of cement-retained implant restoration, adequate retention and resistance form should be present

Till now, titanium has proven to be the most successful abutment material except few mechanical complications.[27]

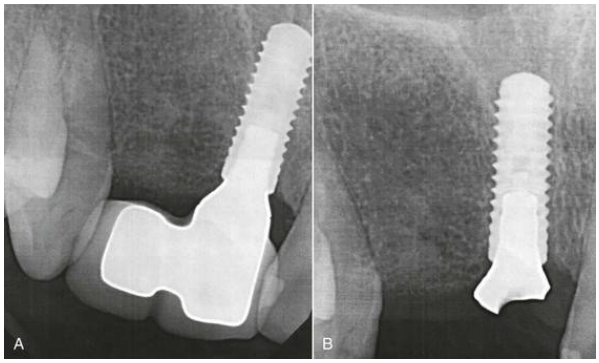


**Fig 10** A- abutment attached to implant
B- fracture of abutment

***Fixture fracture: (Figure 11)***

Fracture of the implant fixture is a rare complication. Implant fractures are dependent on quality of bone**.** A fixture fracture rate of 12.5% in the maxilla and 14.3% in the mandiblehas been reported for Brånemark implants used in single-molar replacements (Schwarz 1991). A mean period of 4.4 years showed incidence of 0.5% of implant fractures.Adell found that only 3-6% cases in maxilla and 3% cases in mandible were associated with fracture of the implant fixture.

***Causes :*** The implant fixture fracture may occur due to following reasons

- Defective material and design of the implant
- Absence of passive fit of the restoration
- Occlusal overload
- Narrow diameter
- Parafunctional habits
- Long cantilever design

***Management***

Rangert *et al*[28] proposed that large diameter implant should be used in molar and premolar region to reduce the chances of fixture fracture.

Treatment of fractured implant fixture includes its removal with the help of trephine bur and placement of larger diameter implant. After successful osseointegration of the replaced implant prosthesis should be given. To reduce the incidence of the fixture fracture occlusal overload, cuspal inclination and size of the prosthetic crown should be corrected.[29] Reduction of the cantilever length was suggested by Shackleton and Slabbert. They proposed that short cantilever reduces the excessive load on the implant.[30] The maximum length of the cantilever for mandible is 15-20 mm and for maxilla is 10 mm. It is suggested that careful, periodic occlusal evaluation and analysis before and after implant restorations should be carried out. A sound adoption of biomechanical principles must also be considered in the planning of combined tooth and implant supported partial dentures.[31]

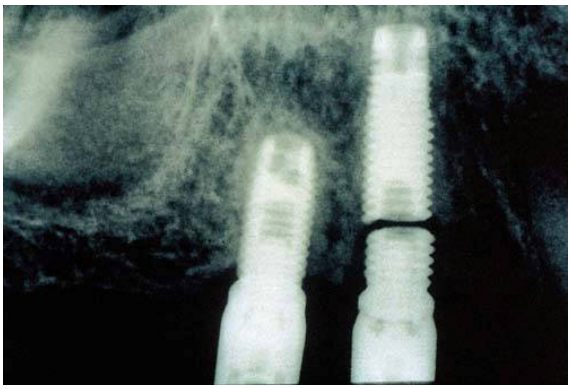

**Fig 11** fracture of dental implant

**Esthetic failures**:**(Figure 12-16)**

Esthetic results of the dental implants cannot be predicted. Implant supported restorations have been considered successful when they mimic adjacent natural teeth in a well balanced soft tissue framework. Henry *et al* in a 5-year study reported 10% incidence rate of esthetic failure of implant.

***Causes of esthetic failure:*** Missing interdental papillae, mucosal recession, poor restoration contour and shade mismatch, Malposed implant may all cause aesthetic failure. Higginbottom and colleagues said that the dental implant restoration should resemble the natural tooth completely. The goal of the dental implant treatment should be the replacement of the missing teeth with a natural looking restoration which blends with the surrounding tissues[32].

***Management :*** Esthetic implant complication can be minimized by the proper treatment plan. The final restoration should be used as a guide for 3-dimensional positioning of the dental implant which can be regarded as key for esthetics. Surgical guides should be used for location and angulation of the dental implants. In case of poor angulation of the implant, angled abutment may be used to solve the esthetic issues. At least 1.5 mm of space should be present between the natural tooth and the dental implant. Two dental implants should be placed with 3 to 4 mm of space in between. This will reduce the resorption of the crestal bone and will help in preserving the soft tissues.[33] A distance of 5-6 mm or lesser should be maintained between the base of the proximal contact and the crest of the alveolar bone for the intact papilla. To prevent the gingival recession in case of thin facial bone, placing the implant 3 mm palatal to the facial bone has been suggested. Other methods include guided bone regeneration onlay grafts, block bone graft along with barrier membrane and distraction osteogenesis. [34]

The thin gingival biotype is more susceptible for the gingival recession hence connective tissue grafting may be required. Sometimes color change around the dental implants has been noticed when the gingival thickness is <2mm. Zirconia abutment along with all ceramic restoration should be used to prevent such complication. Application of pink coloured porcelain on the abutment neck has also been advocated to prevent discoloration the surrounding gingival tissues. Immediate implant, socket augmentation and provisionalization of the dental implants should be considered for the esthetic outcome of the treatment. Patients complaining of poor aesthetics following the completion of treatment can be challenging to manage. Mucogingival graft-ingand the use of pink porcelain may be useful in these cases. However, inadequate treatment planning and poor implant positioning can often not be disguised. [35]

**Fig 12** gingival recession and loss of interdental papilla

**Fig 13** Malpositioned dental implant

**Fig 14** Poorly contoured implant crown

**Fig 15** Poor gingival esthetics of implant crown

**Fig 16** shade mismatch of implant crown

## CONCLUSION

Implant treatment is a very technique sensitive procedure and requires a multidisciplinary approach. Failures are often encountered at different stages of the treatment, be it surgical or prosthetic. A careful treatment planning considering all aspects is must for avoiding the failures.

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