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Implant Failures: A Comprehensive Review

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Abstract

The possible occurrence of implant failure is a major concern for implantologists and knowledge in such unavoidable fact is clinically essential. Failure of a dental implant is often related to the failure of the implant to osseointegrate correctly with the bone, or vice-versa. Implant dentistry is currently being practiced in an atmosphere of enthusiasm and optimism, because our knowledge and ability to provide service to our patients has expanded so greatly in such a short period. Complications do arise in implant dentistry. These are more often due to aging, changing health conditions, long-term wear and tear, poor home care and inadequate professional maintenance. Success cannot be guaranteed, what one can guarantee is to care, to do ones best and to be there to help in the rare instance that something goes wrong, patient appreciate and benefit from straight talk. "Unfortunately failure is often the best teacher". The purpose of this concise review was to discuss the implant complications and failure by highlighting the major etiologic factors as well as the parameters used for evaluating such failure.

Key Words

Implant failure; parameters; complications; osseointegrate

INTRODUCTION

Since the introduction of the concept of osseointegration, the success of implants has increased dramatically because of better understanding of bone response and improvement in bone loading concept. Endosseous dental implants have been a successful treatment alternative for restoring missing teeth. Osseointegrated dental implants represent a widely accepted and documented treatment modality for the rehabilitation of the partially or totally edentulous ridge. However, treatment is not always successful, because implant is a foreign body. The focus of implant research is shifting from descriptions of clinical success to the identification of factors associated with failure (Esposito *et al*., 1999).[1] Some have related failures to biological or microbiological reasons, and others have attributed dental implant failures to biomechanical or biomaterial factors or implants surface treatment and characteristics. Improper patient selection, accumulation of bacterial plaque because of poor oral hygiene, traumatic occlusion, debris retention resulting from improper prosthetic restoration, and bone preparation without the use of internally cooled, high torque, slow speed hand pieces, have been the factors contributing to the breakdown of otherwise successful implants. In addition, researchers have discussed and showed the different reasons for dental implant failure, each from their individual viewpoint and according to clinical observations.

CLASSIFICATION

In discussing the pathogenesis of implant failure, Tonetti and Schmid classified dental implant failures chronologically as

- Early failures
- Late failures

They presented the different elements in the understanding of the elements in the understanding of the biomechanical equilibrium, where osseointegrated implants and the surrounding bone represent a single functional unit that withstands repeated loading cycles. Some authors have studied soft tissue responses, as well as bone response, to dental implants. The concept of failure beyond the

loss of integration has included esthetic, functional and phonetic reasons. With high patient expectations, successful implant integration does not necessarily result in a satisfied patient. Furthermore to avoid or decrease the percentage of failure caused by loading, a loading concept has been introduced by Misch so as to permit the physiology of bone to respond to the additional load; this concept is called progressive bone loading. A better understanding of the factors associated with implant failure provide data for the planning of future studies, facilitate clinical decision-making, and may enhance implant success.

According to Cranin

1) Intraoperative complications

a) Endosteal implants

- Oversized osteotomy
- Perforation of cortical plates
- Fracture of cortical plates
- Inadequate soft tissue flaps for implants coverage
- Broken burs
- Hemorrhage
- Poor angulations or position of an implant
- Injury to the mandiblular neurovascular bundle

Short term complications (first 6 postoperative months)

a) Endosteal implants

- Post operative infection
- Dysesthesia
- Dehiscent wounds
- Dehiscent implants
- Radiolucencies
- Antral complications
- Implant mobility
- Post surgical scar contracture
- Pterygomandibular raphe
- Anterior vestibule

b) Subperiosteal implants

- Strut exposure
- post operative infection
- Scar contracture
- Pterygomandibular raphe
- Anterior Mandibular vestibule

3) Long term complications

a) Endosteal implants.

- Ailing, failing or failed implants.
- Acitisite
- Prosthetic complications.

➢ Fractured root form implants
➢ Implants of improper angulations
➢ Broken prosthesis inserts
➢ Screw problem
➢ Partial loosening of cemented bars or prosthesis
➢ Inaccurate fit of castings
➢ Fracture of blade abutments

b. Subperiosteal implants

- Bone resorption
- Strut dehiscence
- Recurrent pericrevical granulomas
- Broken abutments
- Post subperiosteal sublingual floor elevation.

II) According to Sumiya hobo

- Soft tissue complications
  - Exposure of the cover screw
  - Proliferative gingivitis and fistulae
  - Exposure of fixture threads
- Bone complications
  - Progressive marginal bone loss
  - Fixture mobility
- Mechanical complications:
  - Component fracture
  - Abutment screw fracture
  - Prosthesis screw fracture
  - Functional speech problems
  - Malpositioned fixtures

III) According to Askary *et al*

➢ Ailing implant: Implants exhibiting soft tissue problems exclusively are classified as ailing and have a more favorable prognosis.
➢ Failing implant: An implant that is progressively losing its bone anchorage, but is still clinically stable, can be defined as failing
➢ Failed implant: Implant with mobility excessive bone loss (>70%) not amenable to treatment are failed implant

A. According to etiology

- Host factor
- Surgical factor
- Implant selection factor
- Restorative factor

B. According to condition

- Ailing Implant
- Failing Implant
- Failed Implant

C. According to timing of failure

- Before stage II
- After stage II
- After restoration

D. According to failure mode

- Lack of osseointegration

- Unacceptable aesthetics
- Functional problems
- Psychological problems

E. According to supporting tissue type

- Soft tissue loss
- Bone loss
- Combination

F. According to origin

- Peri implantitis
- Retrograde Peri implantitis

G. According to the condition of failure

- Clinical and radiographic status

SURGICAL COMPLICATIONS:

1. Oversized osteotomy
2. Perforation of cortical plates
3. Fracture of buccal and lingual cortical plates
4. Antral Perforations
5. Inadequate soft tissue flap for implant coverage.
6. Hemorrhage
7. Poor angulations
8. Injuries to the mandibular neurovascular bundle.
9. Failure of Autogenous graft

REVIEW OF LITERATURE

Robert H .Wallace *et al.*, demonstrates that smoking can be detrimental to implant success.[2] David G. Graton *et al.*, investigated implant screw joint micro-motion and dynamic fatigue as a function of varied preload torque applied to abutment screws when tested under simulated clinical loading. Under the loading parameters of this study no measurable fatigue of the implant abutment interface occurred. However, dental implant screw joints tightened to lower preload values exhibited significantly greater micro-motion at the implant abutment interface. Martin *et al.*, concluded that preservation of the buccal supporting bone volume is desirable to obtain physiological modeling response and enhance the facial plate. Insufficient bone volume may result in buccal fenestration or dehiscence, which can precipitate mucosal irritation, decreased support and potential implant failure. Fumihiko Watanabe *et al.*, reported that an implant was placed in an incorrect inclination in spite of cooperation between the surgeon and Prosthodontist. This failure suggested the necessity of clearly presenting the Prosthodontic aspect of treatment to each member of the team before surgical treatment is rendered.[5] Eric T. Ashley *et al.*, reported that it is essential for the clinical to recognize unhealthy implant and to determine whether they are ailing, failing or failed prior to beginning any salvage efforts.[7] Ross Bryant *et al.*, tested the hypothesis that there is no difference in crestal bone loss proximal to oral implants in complete implant prosthesis sites of older and younger adults. No significant differences were found between the groups. However significant differences were found between some old and young subgroups stratified by arch and prosthetic design. Youssef AI Abbari *et al.*, concluded that age should not exclude patients from implant treatment. Early implant intervention is strongly recommended when the patient feels able and is willing to undergo dental and prosthetic therapy.[10] Jerg R. Sturb *et al.*, evaluated the fracture strength and the mode of failure of five different single tooth abutments - implant combinations before and after cyclic loading in artificial mouth. The artificial mouth is useful tool to check the implant screw abutment interface stability. The physical properties of the screw joints of groups 1 (Steri –Oss/Novostil) and group 4 (IMZ Twin +/ esthetic abutment) have to be improved. Groups 2 (Steri-Oss anatomic abudment) (Steri-Oss straight HL) and 5 (Osseolite/gold UCLA) have the potential to withstand biting forces. Robert L. Simon, concluded that the evidence of the successful use of Osseointegrated dental implants for restoration of individual teeth have been reported for anterior teeth more frequently than posterior teeth. The implant failure rate was 4.6% with complications of abutments screw loosening (7%) and loss of cement bond (22%). Osseointegrated implants in molar and premolar positions may be restored as single crowns.[9] Meshram *et al.*, concluded that immediate loading as of now was advocated only in the mandibular interforaminal region with 4 implants each of at least 10 mm in length and achieving bicortical anchorage, being splinted with a bar. Immediate loading should be resorted only if the protocol can be strictly adhered. Charles J Goodarce *et al.*, reported that following 6 categories of clinical complications are associated with implant prosthesis: surgical, implant loss, bone loss, peri implant soft tissue complication, mechanical complication, and esthetic/phonetic complication. Wael Att *et al.*, concluded that when planning dental treatment, practitioner need to consider patient's wishes and requirement.[6] John C. Keller *et al.*, has reported that osteoporosis like bone conditions affects the Osseointegration characteristic of implant, but long term biomechanical stability under forces of mastication is unknown as yet.[14]

Jack E. Lemons, provides information about the interrelation among basic and applied properties from biomaterial, and tissue healing and how properties used to evaluate opportunities and limits of immediate-function dental-implant system. Marco Esposito *et al.,* reported implant with relatively smooth (turned) surface is less prone to lose bone due to chronic infection (Perimplantitis) than with the rougher surface. Sawako Yokoyamaet *et al.,* examined the influence of location of length of implants on stress distribution for three unit posterior FPD's in the posterior mandibular bone. The maximum equivalent stresses were shown at the cervical region in the cortical bone adjacent to the mesial and distal implants. Relatively high stress of up to 73Mpa was shown adjacent to the mesial implant located 9 mm or more posterior to the first premolar. The use of a 12 mm long mesial implant demonstrated a relatively weaker influence on stress reduction. The implant location in the cantilever FPD's was a significant factor influencing the stress created in the bone. Ibrahim Alkan *et al.,* investigated stress distribution on preloaded implant screws in 2 implant to abutment joint systems, under simulated occlusal forces. Although an increase or decrease was demonstrated for the maximum calculated stress values in preloaded screws after occlusal loads, these minimum stress values were well below the yield stress of both abutment and prosthetic screws after occlusal loads, these maximum stress values were well below the yield stress of both the abutment and prosthetic screws of two implant systems tested. The results imply that three implant abutment joint systems tested may not fail under the simulated occlusal forces. Gurcan Eskitascioglu *et al.,* investigated the effect of loading at 1 to 3 locations on the occlusal surface of the tooth on the stress distribution in an implant supported fixed partial denture and surrounding bone, using 3 dimensional finite element analysis. The optimal combination of vertical loading was found to be at 2-3 locations which decreased the stress within the bone. In this situation von Misc stresses were concentrated on the framework and occlusal surface of the FPD. Eduardo Torrado *et al.,* compared the porcelain fracture resistance between screw retained and cement retained implant supported metal ceramic crowns and to assess whether the narrowing of occlusal tables of offsetting the screw access opening affect fracture resistance. Screw retained implant supported metal ceramic crowns demonstrated significantly lower porcelain fracture resistance than cement retained crowns. Placing the screw access opening 1 mm offset from the centre of the occlusal surface did not result in lower fracture resistance. Cement retained crowns with 4 to 5 mm bucco-lingual width or the occlusal surface did not show similar porcelain fracture resistance.[13] Periklis Proussaefs *et al.,* evaluated the clinical parameters of immediately loaded single threaded hydroxyapatite coated root form implants. He concluded that single root form implants may be immediately loaded when placed in the maxillary premolar region.[12] Irene Hermann *et al.,* reported that patient selection appears to be of importance for increasing implant success rate.[16] Peter K. Moy *et al.,* reported that increasing age was strongly associated with the risk of implant failure compared with to patient younger than 40 year; patient in 60 to 79 age group had a significantly higher risk of implant failure. Stephelynn DeLuca *et al.,* reported that overall implant failure was 7.72%. Patients who were smoker at time of implant surgery had significantly higher implant failure (23.08%) than nonsmoker (13.33%). AF Kovacs, concluded that chemotherapy with cis - or and 5-flurorouracil was not detrimental to survival and success of dental implant in mandible.[4] Flavio Domingues das neves *et al.,* reported that short implant should be considered as an alternative to advanced bone augmentation surgeries, since surgeries can involve higher morbidity, requires extended clinical periods, and involves higher costs to the patient.[17] W Chee and S Jivraj, reported most of implant failure can be prevented with proper patient selection and treatment planning.[18] Claudia cristina Montes, reported that most patients presented no clinical cause for implant failure. These result suggested that host factor, not clinically identified clinically, can contribute to an increased risk for implant loss.[19] Levin L *et al.,* long term marginal bone loss around single dental implants affected by current and past smoking habits. Former smokers still demonstrated an increase in marginal bone loss as compared with nonsmokers. There was no difference in implant survival in relation to smoking habits.[21] Bashutski JD *et al.,* in their case report on Implant compression necrosis: current understanding. The case highlights unusual implant failures that likely occurred as a result of overcompression of the bone during placement. Areas involving dense bone seem to be at increased risk for compression necrosis.[22] Abt E, conducted a

study on the effect of smoking on dental implant failures and complications. He concluded that the risk of implant failures and biological complications with and without accompanying augmentation procedures was found to be significantly increased in smokers compared with nonsmokers.

PROSTHODONTIC CONSIDERATION IN IMPLANT FAILURES

The introduction of osseointegrated implants revolutionized the treatment of edentulous patients. There was higher success rates associated with increased comfort and function for the edentulous patients. It soon became evident that implants could be useful in the treatment of the partially edentulous patients, but long term outcome was poor because of complications due to maintenance problems, so they started developing new alloy, new implant configuration, new surface textures and coatings, new screw joints and other new ideas. Ultimately observers began to realize that there was less to do with the implant system rather it was problem with treatment planning concepts and designs.

Forces on Implant

Implants and its components tolerate vertical forces well but not tolerate lateral bending forces because bending elevates stress to implant and bone and should be minimized whenever possible. In case of designing the cantilever edentulous fixed bridge, look for length of implants, the quality of bone, number of implants, the opposing occlusion, but most important factor is anterior and posterior spread of implants. When a patient has occlusion on the cantilevers portion of the edentulous fixed bridge, a fulcrum line is established through the distal most implants, so cantilevered section is pushed towards the tissues, whereas bridge anterior to the dental most implants has tension occlusally bending results through the fulcrum line. On such cases connection of the bridges and placement of anterior implant farther from fulcrum line provides better resistance for cantilevering. If the implants are in more or less a straight line across the edentulous mandible, there is a minimal tripod effect with minimal resistance to bending thus the cantilevered would have to be shortened.

Geometric Load Factors

Increased bending forces on implants have been identified as a major risk factor for implant failure the factors which causes bending forces on implants are;

- Fewer than 3 implants
- Implants connected to tooth
- Implants in a line
- Cantilever extensions
- Occsual plane beyond the implant support (buccal or lingual cantilevering)
- Excessive crown: implant ratio.

Overload on implants causes marginal bone resorption once the resorption exceeds three threads, the weaker portion of the implant below the abutment screw engagement is exposed, this type of bone loss around the implant is described as “cupping” seen as rounded radiographic appearance rather than more horizontal or vertical straight line when this is seen one should suspect the failure due to overload. When a three unit restoration is planned, three implants as the treatment of choice to prevent buccal or lingual bending forced by providing tripod effect.

Crown Implant Ratio

In case of edentulous patients large crown-implant ratios are fabricated because it provides tripod effect, whereas for partially edentulous cases forces are not tolerated well.

Occlusal Design

In partially edentulous cases besides tripod support systems, narrow occlusal table minimizes bending by preventing the forces from being too far beyond the fulcrum line, and it is also important to place the centric contacts over the implants. Because centric contacts lateral to implants creates lateral forces and these remaining natural teeth should provide lateral guidance. If it is not possible to use natural teeth for lateral guidance 3 implants should be placed. In order to centralize the centric contacts over the implants one can design lingualised occlusion in which maxillary lingual cups contacts the mandibular central fossa with no contacts of buccal cups.

Ideal Occlusal Scheme

- Tripod support system
- Narrow occlusal table
- Centric contacts directly over the implants
- Relatively flat cuspal inclination.

Strategic Extractions

When considering implant rehabilitation for partially edentulous patients one should examines the conditions of the adjacent teeth. So, that the patient does not spend considerable time and money replacing missing teeth and then shortly thereafter loses both. By strategically extracting the compromised adjacent teeth one can improve the support design by placing more implants and improving the tripod effects. Some times on

occasion the extraction of adjacent tooth does not necessarily depend on the health of the tooth but rather on the overall rehabilitation.

Single Implant Restorations

The problem inverted in single tooth replacement and single implant are loose screws, fractured implants, this is because the occlusal table of a normal sized molar is relatively large compared with a standard sized implant (3.75-4 mm) the potential for bending is tremendous because of cantilever in all 360^{o} even the occlusal this is remain bucco-lingullay the mesial-distal dimensions must remain full sized to maintain proximal contacts. In order to reduce this wide diameter implants should be used 5 mm diameter implant provides stronger support also, with a wide platform the implant provides a wider seating surface for the restoration. This feature combined with narrower bucco-lingnal dimensions reduces potential bending forces. Main disadvantage with wide diameter implant is it requires extensive removal of bone which may compromise long terms success of the implant.

Tooth Implants Connection

The natural tooth exhibits certain mobility whereas the implant is rigidly anchored is bone threes tooth moves slightly before it counteracts the applied forces, whereas implant is loaded, immediately.

CONCLUSION

Truly to De Vans dictum of meticulous preservation of what remains is more important than meticulous replacement of what is missing, the use of dental implants has to overcome many of the drawbacks of conventional fixed and removable prosthesis. The most desired characteristics of an implant are those that ensure the tissue - implant interface will be established quickly and then will be firmly maintained. Long term success of dental implants was previously based on osseointegration status which was measured by parameters such as mobility, supparation and perimplant bone loss. However more recently they should also meet certain esthetic and functional requirements. The success of dental implants is difficult to predict as it depends on various bio-mechanical factors. It is difficult to assess whether the various modifications in the latest implants deliver improved performance so, it is well established that the failure can occur even under best care. It is often said ***'An implant in the wrong position will always integrate'***. Unfortunately failure to integrate is usually not as difficult to manage as an improperly positioned implant which may affect function and esthetics of the prosthesis. Most of the failures, except loss of integration can be prevented by proper treatment planning and a sound understanding of restorative aspects of dental implants, biomechanics and forces placed on implant restorations and components. That's the key to preventing these types of failures of implant and implant prosthesis with proper meticulous treatment planning.

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