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REVIEW ARTICLE

Failures in Dental Implantology - A Literature Review

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ABSTRACT

Dental implant failure has led to continuous innovations of various implants systems and to different interceptive treatment modalities. These concerns have also led to selection of implant designs that best suit the various types of bone. There are a variety of reasons for the failure of endosseous implants. Different reasons for the implant failure and their contributing factors have been discussed in the review article.

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

- early and
- late failures.

They presented the different elements in the understanding of the elements in the understanding of the biomechanical equilibrium, where osseointegrated

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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.

HISTORICAL BACKGROUND

Man was in a search of ways to replace missing teeth for thousand years. Ancient Egyptians used tooth shaped shells and ivory to replace missing teeth. The Etruscans replaced missing teeth with artificial teeth carved from the bones of oxen.Modern Implant Dentistry began in the early 19th century. A lot of experiments were conducted on what would work best. Attempts were first made at implanting natural teeth from another patient's mouth, but these implants failed due to infection or were rejected by the host tissue. Implants made of gold, porcelain; silver and even lead were being tried, only with a fair measure of success and little or no predictability.

As early as 1918, Greenfield devised the irdoplatinum root form of implants. Other early implants were those of Chercheive, Formiggini and others. An interesting design was Tripodal pin implant of Scialom. Interestingly, some of these early designs were ahead of time.

Their failure to gain widespread popularity could probably be attributed to the fact that

- prosthetic technique,
- antibiotic use,
- infection control,
- instrumentation, and
- impression materials had not yet advanced far enough.

One of the early pioneers in this field Dr.A.E.Stock, in 1931, suggested using Vitallium, a metal alloy for dental implants.In 1947, Manlio Formiggini developed an implant made of tantalum. At the same time, Raphel Chercheve was using implants made of chrome-cobalt alloy. By **1964, commercially pure titanium was accepted as the material of choice for dental implants.** Since then almost all dental implants are made of titanium. The body does not recognize titanium as a foreign material, resulting in less host rejection of the implant. Other areas of medicine recognize this fact and use titanium for *other* implants, such as joint replacements and heart valves.In 1950's startling discovery was made which had great implications for tooth replacement therapy. During an experiment, involving study of blood circulation in animals, Dr. Per-Ingvar Branemark discovered that hollow titanium rod used in the study was not retrievable when the experiment was complete. Further studies showed that the animals bone had directly attached to the titanium surface. This phenomenon was called osseointegration, defined by the America academy of Implant Dentistry as - "the firm, direct and lasting biological attachment of a metallic implant to vital bone with no intervening connective tissue." This firm anchor is what makes the implant wonderful option for replacing teeth. fIn 1941 Dr. Gustav Dahl of Sweden provided a retentive mechanism for jaws that were completely edentulous. This was the introduction of subperisoteal implant. Dr. Leonard Linkow of New York introduced the blade form implant in 1967. These blades came in a variety of sizes and forms and were the most widely used form of implants till 1980's.

REVIEW OF LITERATURE

Richard Shalak[1] in 1983 studied on the biomechanical considerations of Osseointegrated prostheses and concluded that the critical aspect affecting the success or failure of the implant is the manner in which mechanical stress is transferred from the implant to the bone. The Osseo integrated implant provides a direct contact with the bone and therefore will transmit any stress waves or shocks applied to the fixtures. For this reason it is advisable to use shock absorbing material such as acrylic resin in the form of acrylic resin artificial teeth in fixed partial dentures.

Adell[2] in 1983 studied on Osseointegrated implants supporting fixed prostheses in edentulous jaws. The material comprised a total of about 4100 implants installed in 650 jaws of 600 patients. He concluded that the anchorage function for fixtures and, as a consequence, the anchorage for prostheses depended on a maintained Osseo integration and on a maintained marginal bone height. The number of fixtures lost was small.

Lars W.Lindquist[3] et.al in 1988 reported that bone loss around Osseo integrated titanium fixtures supporting mandibular fixed prostheses has been measured by means of stereoscopic intraoral radiography. The bone loss was small; during first post surgical year .Poor oral hygiene and clenching of teeth significantly influenced bone loss.

Albrektsson[4] in 1988 in a study reported gingival complications in the form of mucosal perforations and fistulae showed an incidence of 38 to 39 observations in **11** team study. Mechanical complications such as fracture of abutment screw, fixture, or prosthesis was reported to occur in 3 to 5 % of the cases.

D. van Steenberghe[5] in 1989 did a retrospective multicenter evaluation of survival rate of osseointegrated fixtures supporting fixed partial prostheses in the treatment of partial edentulism. The most failures occurred before prosthetic rehabilitation. The mean maximum between the margin of the bone and the fixture abutment junction was 2.5 mm. Since only two of the 53 fixed prostheses were lost during observation period and since most fixture losses occurred before prosthetic phase of the treatment this study supports the concept that osseointegrated prostheses can also be applied in the rehabilitation of partial edentulism.

E. A. McGlumphy[6] et al in 1989 compared stress transfer characteristics of dental implant with rigid and resilient internal element. It has been suggested that there is a unique set of problems associated with joining an implant and a natural tooth with a fixed partial denture.

Amerian D .Sones[7], in 1989 reported fixtures are being successfully integrated within the residual bone.sucessful reconstruction however means more than successful integration. Function and esthetic prostheses involve careful diagnosis and fixture placement.

M. R. Rieger[8] et al in 1990 did a finite element analysis of six endosseous implants. Comparisons were made by using Branemark, Core-vent, Denar, Miter, Stryker and experimental implant designs. The study concluded that apical "punching stress" with all implants were not clinically significant. Saucerisation resulted from biomechanical overloads could be a possibility for three of the implants.

I. P. van Rossen[9] et al in 1990 by means of finite element analysis calculated the stress distribution in bone around implants with and without stress absorbing elements. For a freestanding implant it was concluded that variation of E modulus of the stress absorbing element had no effect on the stress in the bone. For implant connected with natural tooth, it was concluded that more uniform stress was obtained around implant with low E- modulus of the stress absorbing element.

G.A.Zarb and Schmitt[10]. in 1990 reported that Osseo integrated implant is a predictably safe analogue for tooth root, capable of supporting prostheses in edentulous jaws.

Naert, Quirynen[11] et al in 1992 reported that the location of fixtures, the occlusal design, and fixed prosthesis in both jaw influence prosthetic and implant complication.

R.J.Weyant[12] and B.A.Burt in 1993 reported that clustering of implant however would indicate that certain systemic factor play an important role in determining whether a particular patient will be able to tolerate implant and the role of implant coating as they related to survival should be explored in clinical trial.

Marcus A.R.Lima Verde[13] et al . in 1994 reported that despite careful treatment unfavorable inclination of implant is not uncommon .The IMPAC custom abutment system uses an uncomplicated manual tapping device that reorient the screw hole in custom –fabricated abutment.

Russell A. Wick[14] in 1994 reported that thoughtful design selection is crucial for the perpetual success of any dental implant restoration. Deviations from the originally planned design may be necessary at time. Indications for the selection of specific prosthetic modalities are offered in a sequence of paradigms to support the cognitive skills of the inexperienced clinician.

Arthur M. Rodriguez[15], Stwen A. Aquilino, and Peter S. Lund, in 1994 reported that Implant research has progressed from basic information pertaining to materials, placement techniques, and restorations to clinical and theoretical studies addressing characteristics such as loading, stress, flexibility and biological responses.

Robert Hass[16] et.al in 1995 reported that most common complication observed was abutment screw loosening. Because the clinical and esthetic result of implant for single tooth restoration can be recommended.

William Becker[17] et.al in 1995 reported that factors such as bone quality, quantity, length of implant, and minimized occlusal contacts may have contributed to favorable success rate. The main complication was loosening of gold retaining screw.

Zarb and Schmitt[18] in 1995 reported salient aspects which impact upon decision making with implant supported prosthesis. He emphasizes the predominance of bone structure in selecting the most likely favorable treatment outcome.

James C. Taylor[19] et al in 1996 presented a clinical report that illustrated the in vivo surface degradation of an HA coated dental implant similar to that reported in literature. Current conflicts in the clinical and biomaterial literature suggest that longer term data need to be accumulated to validate the continued use of HA coated implants.

M. E. Geertman[20] et al in 1996 evaluated the effect of over dentures on different implant systems in patients with severely resorbed mandibles were compared 1 year after insertion of the new dentures. During the healing period one IMZ and one BRA implant were lost and one TMI implant was removed after functional loading.

Cynthia P. Thiel[21] et al in 1996 presented a clinical report of combination syndrome associated with a mandibular endosseous implant retained over denture opposing a maxillary complete denture unsupported by implants. The increased force generation permitted by the osseointegrated implant coupled with anterior functional contact encourages resorption of the anterior maxillary ridge. Chronic ridge resorption can lead to all of the symptoms of combination syndrome.

Atilla Sertgoz[22] et al. in 1996 reported that (a)maximum stresses were concentrated at the most distal bone /implant interface, located on loaded side of terminal implant .(b)increasing cantilever length resulted in increase stress value at bone /implant interface.(c)implant length had no appreciable effect on stress distribution at the bone/implant interfaces.

Shaker Iyer[23] et al in 1997 conclude that when using a 700 XL carbide bur ,high speed (maximum 400,000 rpm) water-cooled drilling produce significantly less heat than either low speed (maximum 2,000 rpm) drilling.

Paul A .Fugazzotto[24]. in 1997 examined the stability of regenerated bone around implant in function. Reported that regenerated bone demonstrated to be capable of supporting implant and responding to functional force in healthy, predictable manner.

Ann M. Parein[25] et al in 1997 evaluated the long term outcome the type and prevalence of prosthetic complications in a series of patients treated consecutively with Branemark implants in the partially edentulous mandible. Significantly fewer major complications were found in prostheses supported by one or more implants, located exclusively in premolar sites, versus prostheses supported by either molar implant or

both premolar and molar implants. In single tooth restorations fewer major complications were seen in the cemented restorations, compared with screw retained.

Regina Mericke-Stern[26] in 1998 demonstrated the high success rate, usefulness and reliability of mandibular over dentures. It is necessary that maxillary over dentures also become a well established and reliable treatment option for edentulous patients.

Adrianne Schmitt[27] et al in 1998 presented a brief review of methods and techniques to manage the maladaptive edentulous patient. It is concluded that there is a need for less invasive, less expensive, less complex and equally effective treatment option such as implant supported over denture for the maladaptive edentulous patient.

Mohamed Moataz Khamis[28] et al in 1998 studied and compared the masticatory efficiency of three occlusal forms, 0 degrees, 30 degrees and lingualised occlusion in subjects with mandibular implant over dentures and determined their effects on the implant supporting tissues. Chewing efficiency tests and patient preference rating showed that 30 degrees teeth and lingual contact provided better chewing efficiency than 0 degree teeth.

Esposito M ,Hirsch J-M,Lekholm U[29], Thomsen p in 1998 have presented review regarding factors associated with the loss of oral implant .The review identifies following factors – medical status of patients , smoking ,bone quality ,bone grafting, irradiation theapy,parafuction, operator experience ,degree of surgical trauma ,bacterial contamination, lack of preoperative antibiotic, immediate loading , non submerged procedure ,number of implant supporting a prosthesis ,implant surface characteristic and design.

James Torosian[30] et al. in 1998 reported a review. He quoted that a moderate degree of success in treating failing, but not failed implant.

R. Steven Boggan[31] et al in 1999 did laboratory investigation to examine the, influence of design factors such as platform diameter and hex height on the mechanical strength and quality of fit of the implant abutment interface. The 5 mm diameter implant was stronger in both static and fatigue conditions than 4 mm diameter implants.

Young Hwan[32] et al in 1999 evaluated the effectiveness of expandable implant design for immediate and delayed loading and for freestanding and multiunit situations. The overall survival rate during 40 month period was 96% in the maxillae and 98.4% in the mandible. Implants replaced in fresh extraction sockets showed 98.9% survival rate. Within the limitations of this study it was shown that the feature of mechanical expandability may provide operators some control over implant stability during the vulnerable period after immediate loading of single freestanding implants.

Charles J. Goodacre[33] et al in 1999 attempted to determine the different types of complications that have been reported. He concluded that greater implant loss occurred with over dentures other than with other types of prostheses. There was greater loss in the maxilla than mandible with fixed complete dentures and over dentures whereas little difference was noted with fixed partial dentures.

Robert H .Wallace[34] et al in 2000 demonstrates that smoking can be detrimental to implant success.

Martin[35] et al in 2001 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[36] et al in 2002 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.

Eric T. Ashley[37] et al in 2003 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.

Ross Bryant[38] et al in 2003 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[39] et al in 2003 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.

Robert L. Simon[40] in 2003 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.

Meshram et al in 2003 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 to.

Charles J.Goodarce[41] et al in 2003 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. The most common is surgical complication.

Wael Att[42] et al in 2003 concluded that when planning dental treatment, practitioner need to consider patients wishes and requirement.

John C.Keller[43] et al in 2004 has reported that osteoporosis like bone conditions affects the Osseo integration characteristic of implant, but long term biomechanical stability under forces of mastication is unknown as yet.

Jack E.Lemons, in 2004 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 in 2004 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[44] et al in 2004 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 in 2004 investigated stress distribution on preloaded implant screws in 2 implant to abutment joint systems, under simulated occlusal forces.

Gurcan Eskitascioglu et al in 2004 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[45] et al in 2004 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.

Periklis Proussaefs[46] et al in 2004 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.

Irene Hermann[47] et.al in 2005 reported that patient selection appears to be of importance for increasing implant success rate.

Peter K.Moy[48], et.al in 2005 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[49] et .al in 2006 reported that overall implant failure was 7.72%. Patient who where smoker at time of implant surgery had significantly higher implant failure (23.08%) than nonsmoker (13.33%).

A.F.Kovacs in 2006 concluded that chemotherapy with cis - or and 5-flurorouracil was not detrimental to survival and success of dental implant in mandible.

Flavio Domingues[50] das neves et al in 2006 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.

W.Chee and S.Jivraj[51] in 2007 reported most of implant failure can be prevented with proper patient selection and treatment planning.

Claudia cristina Montes[52], in 2007 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.

Levin L[53], Hertzberg R, Har-Nes S, Schwartz-Arad D in 2008 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.

Bashutski JD[54],D'Silva NJ,Wang HL in 2009 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.

Abt E[55] in 2009 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

CONCLUSION

The various studies done on each of these failures and how to prevent these failures have been discussed too. Failure of implant has a multifactor dimension. Often many factors come together to cause the ultimate failure of the implant. One needs to identify the cause not just to treat the present condition but also as a learning experience for future treatments. Proper data collection, patient feedback, and accurate diagnostic tool will help point out the reason for failure. An early intervention is always possible if regular check-up are undertaken.

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