

Reasons For the Dental Implant Failure and Its Complications – A Literature Review

Priscilla Shalini S^{*1}, Bhuminathan S², Lakshmi Prasanna S³, Nithyapriya S.⁴

^{*1}PhD Scholer, Department of Prosthodontics, Sree Balaji Dental College and Hospital, Chennai. 600100

²Professor, Sree Balaji Dental College and Hospital, Chennai. 600100

Email ID: bhumi.sbdch@gmail.com

³Assistant Professor, Sree Balaji Dental College and Hospital, Chennai 600100.

Email ID: lakshmiprasanna.pros@sbdch.bharathuniv.ac.in

⁴Reader, Adhiparasakthi Dental College and Hospital, Melmaruvathur. 603319

Email ID: nithul219@gmail.com

***Corresponding author:**

Priscilla Shalini S

Email ID: priscilla.shalini@yahoo.com

Cite this paper as: Priscilla Shalini S, Bhuminathan S, Lakshmi Prasanna S, Nithyapriya S., (2025) Reasons For the Dental Implant Failure and Its Complications – A Literature Review. *Journal of Neonatal Surgery*, 14 (32s), 4856-4863.

ABSTRACT

Dentists are increasingly integrating artificial intelligence into their practices as technology advances around the world. Dental implant placement is constantly being refined by dentists. In the past few decades, dental and facial implants have evolved from being a hopeful possibility into one of the most rewarding solutions for patients and healthcare professionals. There is a high success rate for implant-supported restorations over the long term. Many clinicians view complications and implant failures as major obstacles to implant treatment, despite their success. While implant therapy has made some improvements, it still relies on biological healing and integration. Implants and complications can result from these intricate biological processes, which can be affected by local or systemic factors. Effectively managing patients with certain risk factors and being ready to handle any difficulties or failures are critical for dental professionals and implant surgeons. The purpose of this article is to examine typical issues related to implant failure, talk about how to handle them, and offer advice to medical professionals regarding implant placement and repair.

Keywords: Dental implant failure, implant complications, biological and mechanical complications.

1. INTRODUCTION

Losing teeth can lead to functional, aesthetic, and social challenges and potentially reduce a person's quality of life. It can also serve as a significant indicator of the overall oral health of a human population. The most common causes of tooth extractions are dental caries and periodontal diseases.^{1,2} When a tooth is lost, individuals often seek replacements to restore functionality and aesthetics. For over fifty years, missing teeth can be replaced with dental implants, also referred to as endosseous implants or oral implants. In the field of dentistry, dental implants are considered a significant advancement.

They have revolutionized the replacement of missing teeth, achieving a high success rate. The success of this procedure depends on the implant material's capacity to integrate with the surrounding tissue seamlessly. The successful integration of implants depends on several factors, such as the type of implant material used, the quality and quantity of bone present, and the loading conditions applied to the implant.³⁻⁵ Although success rates for dental implants are frequently reported as high. However, there is still a shortage of comprehensive long-term data in the literature regarding the follow-up of implants in function for at least five years or longer. According to the literature, implant success and failure predictors are typically classified into patient-related factors.

Statistical analysis has identified several factors associated with dental implant failure. Age, sex, smoking habits, systemic diseases, implant location in the maxilla, bone quality and quantity, and treatment and characteristics of the implant surface all contribute to implant success. Additionally, immunological and genetic factors are believed to be responsible for early implant failure.⁶ Implant failure is linked to smoking and periodontitis. Smoking reduces vascularity in local tissues and inhibits healing, chemotaxis, and immunity. The failure rate among diabetic patients increased after the first year of

functional loading, according to Mellado-Valero and colleagues. During dental implant placement, irradiated bone or excessive temperature elevation may result in necrosis of the surrounding bone, resulting in implant failure.⁷ This article aims to explore common complications associated with implant failure and their management and to aid clinicians in achieving more effective and less discomforting implant placement and restoration.

According to Consensus Statement of the 6th European Workshop on Periodontology, implant failure can be classified into early and late.⁸ Early failure pertains to an implant that has not achieved successful osseointegration, resulting in premature failure. Complications related to the restoration process are the primary cause of implant failures after the implant has successfully osseointegrated with the bone.⁹ In prosthetics or during the surgical implant procedure, a complication is a secondary issue.¹⁰ Implant complications were classified into biological and mechanical categories by Esposito et al.

2. BIOLOGIC COMPLICATION

An elevated chance of failure is indicated by a biological problem. Treatment may help manage it or it may be transitory. Making the distinction between biological issues and failed implants is essential. In clinical terms, implant mobility indicates a failed implant, usually because of a lack of osseointegration. A "failing" implant is one that exhibits increasing bone loss while maintaining clinical stability. Biological complications around implants can be categorized into the following types:

Biological Complication
1. Inflammation and proliferation 2. Dehiscence and recession 3. Peri – implantitis and 4. Implant failure.¹¹

1. Inflammation and proliferation:

Implant surgery always results in an inflammatory response. Swelling, bleeding, exudate, redness, fistula and necrotic tissue, following implant surgery should be carefully observed. About 50% of patients experience swelling, infection, bleeding, and adverse tissue changes; however, fewer than 1% of these cases are severe. In the anterior segments, the above complications are more common. There are several biological complications associated with the healing of an implant, such as pressure ulcers, peri-implant mucositis, hyperplastic mucositis, and fistulae.

During the initial healing period following an implant's surgical placement, peri-implant mucositis occurs with no additional bone loss beyond the initial bone remodeling that occurs during the healing period. Peri-implant mucositis is defined as inflammation around dental implants by the American Academy of Periodontology. Peri-implant mucositis is estimated to affect 30.7% of implants and 63.4% of patients. There is an odds ratio of 3.8 between smoking and severe peri-implant mucositis. Clinical observations reveal that sites with peri-implant mucositis often show a significant rise in bleeding on probing (BOP), which can reach 67%. Other indicators may include swelling, erythema and suppuration.

Bacterial biofilms that form around dental implants lead to the development of peri implant mucositis from healthy peri-implant mucosa. The fundamental cause of loose abutment connections and retained cement must be understood and appropriately handled in order to reduce inflammation and proliferation. Treatment for peri-implant mucositis generally involves nonsurgical therapy, which includes both supragingival and subgingival debridement, with or without additional adjunctive measures. Studies have demonstrated that chlorhexidine, systemic administration of azithromycin, and glycine powder air polishing are ineffective in providing long-term treatment for peri-implant mucositis. Toothpaste containing 0.3% triclosan has been identified as the only effective treatment for peri-implant mucositis.¹²

2. Dehiscence and recession

After tooth extraction, further loss of alveolar bone is inevitable. The height of the buccal ridge typically decreases by about 2 mm. Reports show an average marginal mucosa regression of 0.5 mm when quick implant insertion is carried out while maintaining the buccal lamella. Clinicians should anticipate this occurrence to prevent or effectively manage potential complications.¹³ Implant loading procedures and immediate implant insertion are linked to the highest risk of problems. In contrast, other protocols show minimal to no significant distinction between early and immediate placement strategies in the aesthetic zone. The patient's soft tissue biotype and the position of the underlying bone both affect the gingiva's position. The soft tissue margin may apically shift as a result of a thin tissue biotype.¹⁴ Peri-implantitis affecting an implant can cause peri-implant bone loss, which may subsequently lead to soft tissue resorption. Bone loss and recession can lead to a darker appearance of the gingival tissues, particularly when an underlying metal abutment is present. Ridge recontouring and bone

loss surrounding a periodontally challenged tooth are linked to midfacial gingival recession, which is linked to the buccal shoulder location of the implant recession of the mesial and distal papillae.¹⁵ In cases of wound dehiscence, it is crucial to perform both clinical and radiographic evaluations. A two-stage procedure requires immediate intervention if signs such as fistulae, swelling, or persistent pain are noted during the submerged stage. Identifying whether the issue affects only soft tissues or hard tissues is crucial. In addition, irregularly seated cover screws, premature wear of dentures, and inadequate denture relief over protruding implants can lead to soft tissue dehiscence. Another factor contributing to gingival recession is incorrect implant positioning. It has been demonstrated that too far buccal implants result in recession at a three-fold higher rate than those placed too narrowly. A careful pre-planning should be done for soft tissue and bone augmentations, and suitable modifications to prostheses should be considered.¹⁶

3. Peri-implantitis

An implant-related pathological condition, peri-implantitis affects the tissues surrounding the implant. During this condition, the supporting bone is continually lost until the peri-implant mucosa is inflamed and inflamed.¹⁷ The inflammation process around a dental implant is typically more severe, deeper, and the adjacent natural tooth will not progress as fast as an infected tooth. Most dental implant failures are caused by cocci and nonmotile rods present in the subgingival microflora.¹⁸ The following criteria are used to diagnose peri-implantitis:

1. The existence of suppuration and/or hemorrhage when gently probed,
2. A deeper level of probing than in earlier tests,
3. There is extensive bone loss in the crestal bone level that extends beyond the original changes in bone remodelling. Soft laser irradiation has proven effective in eliminating the bacterial pathogens responsible for peri-implantitis.

4. Implant failure/loss

When mechanical or biological problems prevent an implant from serving its intended role, whether it be phonetic, aesthetic, or functional, the implant fails. Clinical indicators such early infection, pain or sensitivity, and visible motion during examination can be used to diagnose implant failures. On rare occasions, patients may have implant mobility even when there are no discernible radiographic alterations in the bone. In every instance, mobility serves as the primary indicator of implant failure. Rotational mobility, lateral or horizontal mobility, and axial or vertical mobility are among the different forms of motion that have been observed.¹⁹

The following risk factors for implant failure have been statistically examined:

1. Smoking,
2. Age,
3. Diseases of the system,
4. Location of maxillary implants,
5. Bone quantity and quality,
6. Immunological conditions,
7. Radiated bone,
8. Bleeding disorders,
9. Organ transplantation, and
10. Genetic factors.

Age

The success of implants is thought to be significantly influenced by age.

Elderly people frequently have worse local bone issues, may take longer to mend, and are more likely to have changed systemic health conditions.²⁰ According to Moy et al.²¹, the probability of implant failure increases with age. In a long-term follow-up research on cumulative success rates, Brocard et al.²² found that implant survival rates were lower in patients over 60 years than in the general population. Throughout adulthood, implant submersion persists, with varying rates according to age. The age at which growth is completed varies significantly among patients.

Smoking

Oral and general health are affected by smoking. In addition to reducing chemotactic migration and phagocytic activity, smoking also lowers infection resistance and delays wound healing. Smoking also interferes with calcium absorption. Smokers have a lower survival rate for dental implants. Because of increased peripheral resistance and platelet aggregation, smoking reduces blood flow rate during osseointegration. A smoker's body is less able to heal wounds because of the residues

found in cigarette smoke, such as carbon monoxide and cyanide. Additionally, these residues are inhibitory of cell proliferation, in addition to nicotine. Smoking directly inhibits osteoblast function. According to Strietzel et al., smoking affects implant success regardless of augmentations. Comparing smokers to non smokers, studies reveal a considerable marginal loss of bone.²³

Systemic diseases

Systemic diseases such as diabetes mellitus, cardiovascular diseases, and osteoporosis have previously been identified as potential risk factors.

Diabetes Mellitus

Dental implant osseointegration may potentially be impacted by diabetes mellitus. Hyperglycemia hinders osteoblast formation and alters the response of parathyroid hormone, which is essential for controlling the metabolism of calcium and phosphorus. It has an impact on the adhesion, development, and accumulation of the extracellular matrix as well as the bone matrix and its constituent parts. After insulin treatment, normal glucose levels promote osteoid production and bone matrix expansion. On the other hand, following circumferential osteotomies, diabetes can decrease bone healing by as much as 40%. Microangiopathy is a condition linked to diabetes that is frequently blamed for failures that occur within the first year of functional loading and following the second-phase procedure. This can jeopardize the flap's vascularization, leading to soft tissue infection and slowed wound healing.²⁴

Cardiovascular disease

By lowering cell activity, function and collagen synthesis, cardiovascular disorders interfere with the processes of healing and osseointegration. These conditions include coronary artery disease, atherosclerosis, and high blood pressure. The long-term success rate of dental implant treatment is not substantially impacted by cardiovascular disease.²⁵

Osteoporotic patients

In osteoporotic patients, the failure of osseointegration is attributed to reduced bone density and mass. If osteoporosis is identified at a particular location in the skeleton, it may not always affect the jawbones. Bisphosphonates administered intravenously are linked to jaw osteonecrosis. There have been sixty-three reports of people with osteoporosis or cancer developing jaw osteonecrosis. Patients receiving long-term bisphosphonate therapy should be treated cautiously when receiving implant therapy.^{26,27}

Implant location

An implant or graft material may be lost into the maxillary sinus if it is placed right into fragile residual bone. This can interfere with mastication and disturb the normal ciliary movement in the maxillary sinus, especially if the bone thickness is less than 5 mm. This issue can be addressed surgically through various methods, including intraoral approaches, endoscopic techniques, transnasal routes, and maxillary bone reconstruction.^{28,29}

Quality and quantity of bone

Numerous studies emphasize the significance of bone quality on the success of implants. Four categories of bone quality are distinguished by the degree of corticalization. Larger trabecular gaps, less mineralized cancellous bone, and less cortical bone are the hallmarks of type four bone, which has a high rate of implant failures. Because of its biomechanical characteristics, this kind of bone often fails to provide the necessary primary stability for the implant, which is essential for establishing a strong bone-to-implant contact.³⁰

Immunological deficiency

Immune system weaknesses make people more vulnerable to infections and have trouble repairing damaged tissue. According to recent studies, dental implant operations have been completed successfully in patients with stable immune systems, including those with HIV who have adequate CD4+ cell counts and are taking antiviral drugs.³¹

Radiated bone

For malignant tumors in the craniofacial region, the standard treatment strategy often consists of radiation therapy and surgical excision. Seventy percent of dental implants placed in irradiated bone are successful. Implant success rates have been shown to increase when irradiated individuals receive hyperbaric oxygen therapy before receiving implant treatment.³²

Bleeding disorders

Uncontrolled bleeding can be caused by platelet disorders, deficiencies in coagulation factors, and anticoagulant medications like aspirin and warfarin. This condition occurs due to a deficiency in platelets, typically when their levels fall below 50,000 per cubic meter. In these patients, the most severe adverse effect of dental implants is upper airway obstruction, which can be potentially life-threatening.³³

Organ transplantation

Patients who have received organ transplants need to take immunosuppressant medications long-term for preventing rejection of grafts. Steroids, which have anti-inflammatory properties, are often used in conjunction with cyclosporine A. Around dental implants, cyclosporine may impair both mechanical retention and bone healing.³⁴

Genetic factors

In the promoter region of the MMP1 gene, the G-1607GG polymorphism may contribute to early implant failure. This polymorphism could potentially act as a genetic marker for identifying implants that are at higher risk of failure. Identifying genetic markers linked to early implant failure could have significant clinical value by allowing for the precise and early detection of individuals at high risk for implant loss.³⁵

3. MECHANICAL COMPLICATIONS

Mechanical issues are linked to fractures of components or implant prostheses. When the materials are not strong enough to withstand chewing forces, mechanical issues arise. Several types of mechanical failures have been documented, including fractures of veneering ceramics, dislodgement of screw access hole restorations, loosening of abutment or occlusal screws, fractures of abutments or occlusal screws, and fractures of the implants themselves. The literature also highlights other issues such as loosening of the overdenture retentive mechanism, fractures of resin veneers in fixed partial dentures (FPDs), the need for overdenture relining, and fractures of the overdenture bar or clip.³⁶

Screw and cement restoration

The patient's occlusion and aesthetics may be jeopardized by the necessary screw access hole in the implant. Furthermore, because there is less material used, it can make the restoration weaker. The risk of screw-related problems is also increased by the presence of the prosthetic screw. The passive fit between the restoration and the supporting implants also has a significant impact on this kind of restoration. Compared to cement-retained restorations, screw-retained restorations may be more likely to experience postoperative problems, according to the literature. According to Duncan et al.³⁷, prosthetic screws and filler material in the screw access holes caused problems for patients with screw-retained restorations. In contrast, throughout a three-year period, no issues were noted in individuals who had cement-retained restorations. Cement-retained fixed partial dentures (FPDs) may lead to lower strain levels than conventional screw-retained ones, according to Karl et al.³⁸. Future difficulties may be more likely if there is increased strain during delivery.

Screw loosening and fracture

There are several reasons why screws loosen and fracture, including insufficient torque application, inaccurate framework-abutment interfaces, and excessive cantilever extension. Generally, prosthetic gold screws need a torque of 10 N cm, while abutment screws require a torque of 20 N cm. The necessary torque can be attained using a torque driver in conjunction with a torque converter with manual control. A follow-up hygiene appointment is scheduled both after delivery of the prosthesis as well as during the initial fitting of the prosthesis for loosening. The movement of a prosthesis is assessed by examining saliva percolation at its interface. Any loose screws should be replaced as needed.

Cantilever extension

Cantilever distance beyond distal implant determines the length of lever arm. Implants, frameworks, and prosthetic components are subjected to greater forces as the cantilever extension lengthens. Implants may become fractured as a result of a longer cantilever that loosens screws and abutments. It is advised that the cantilever extension should not exceed 15 mm for the mandible and 10 mm for the maxillary arch.

Occlusal wear

Implant-supported restorations often experience more occlusal wear when opposing restorations are made from different materials. **When porcelain is in contact with enamel, metal, resin, or even other porcelain, it can display abrasive characteristics, especially if it has not been polished thoroughly.**³⁹ Porcelain can be extremely abrasive if exposed to an opaque layer or if external characterizations are done with metal oxides.

Implant fracture

Fatigue or trauma may cause implant fractures. A fracture usually occurs at the level of the abutment. It is necessary to remove the fractured fragments. However, if the apical region is not planned for replacement, it should be left in place. The apical portion usually becomes osseointegrated, and removing it might require extensive trimming of the surrounding alveolar bone. There are three types of factors that can cause implant fractures, according to Balshi et al: design and material issues, passive fitting of the prosthesis framework, and physiological or biomechanical overload. In rare cases, implant-supported fixed complete dentures may break at the midline due to prosthesis fractures. This type of complication might be caused by the flexure of the mandible during function. A two-piece fixed restoration has been recommended as a solution to this problem. This type of fracture is attributed to the mandible's flexure during function. Using a two-piece fixed restoration

can help to lessen it.⁴¹

4. CONCLUSION

Addressing the underlying cause is essential for achieving success. Comprehensive treatment planning, with careful consideration of potential outcomes, is necessary to prevent complications. The clinician should be well-versed in treatment outcomes to effectively manage any complications that may arise. It is imperative that dental implantology practitioners increase their understanding and consciousness of potential risk factors that may contribute to implant failures. Workshops and ongoing dental education programs can help accomplish this goal. Enhancing practitioners' proficiency with implants requires regular evaluation of their theoretical understanding and practical implant dentistry skills.

REFERENCES

- [1] Murray H, Locker D, Kay EJ. "Patterns and reasons for tooth extractions in general dental practice in Ontario, Canada. *Community Dent Oral Epidemiol.* 1996;24:196–200.
- [2] Reich E, Hiller KA. Reasons for tooth extraction in the Western states of Germany. *Community Dent Oral Epidemiol.* 1993;21:379–83.
- [3] Gokcen-Rohlig B, Yaltirik M, Ozer S, Tuncer ED, Evlioglu G. Survival and success of ITI implants and prostheses: retrospective study of cases with 5-year follow-up. *Eur J Dent* 2009; 3: 42–49.
- [4] 2. Baig MR, Rajan M. Effects of smoking on the outcome of implant treatment: a literature review. *Indian J Dent Res* 2007; 18: 190–195.
- [5] 3. Zupnik J, Kim S-W, Ravens D, Karimbux N, Guze K. Factors associated with dental implant survival: a 4-year retrospective analysis. *J Periodontol* 2011; 82: 1390–1395
- [6] Leite MF, Santos MC, de Souza AP, Line SR. Osseointegrated implant failure associated with MMP-1 promotor polymorphisms (-1607 and -519). *Int J Oral Maxillofac Implants* 2008;23:653-8.
- [7] Mishra SK, Chowdhary R. Heat generated by dental implant drills during osteotomy-a review: Heat generated by dental implant drills. *J Indian Prosthodont Soc* 2014;14:131-43.
- [8] Lindhe J, Meyle J. Peri-implant diseases: consensus report of the 6th European Workshop on Periodontology. *J Clin Periodontol* 2008; 35(Suppl 8): 282–285
- [9] Chen S, Darby I. Dental implants: maintenance, care and treatment of peri-implant infection. *Aust Dent J* 2003; 48: 212–220.
- [10] Goodacre CJ, Kan JYK, Rungcharassaeng K. Clinical complications of osseointegrated implants. *J Prosthet Dent* 1999; 81:537-52
- [11] Esposito M, Jan Hirsch, Ulf Lekholm, et al. Differential diagnosis and treatment strategies for biologic complications and failing oral implants: a review of the literature. *Int J Oral Maxillofac Implants.*1999; 14(4):473- 90.
- [12] Ata-Ali J et al. Treatment of periimplant mucositis: a systematic review of randomized controlled trials. *Implant Dentistry* 2015;24(1):13-18.
- [13] Zuiderveld EG. Significance of bucco-palatal implant position, gingival biotype, platform-switching and pre-implant bone augmentation on the level of the mid-buccal mucosa. *The International Journal of Prosthodontics* 2014;27:477-479.
- [14] Lang NP, Loe H. The relationship between the width of keratinized gingiva and gingival health. *Journal of Periodontology* 1972;43(10): 623-627.
- [15] Cosyn J et al. Predictors of inter-proximal and midfacial recession following single implant treatment in the anterior maxilla: A multivariate analysis. *Journal of Clinical Periodontology* 2012;39(9):895-903.
- [16] Zuiderveld EG. Significance of bucco-palatal implant position, gingival biotype, platform-switching and pre-implant bone augmentation on the level of the mid-buccal mucosa. *The International Journal of Prosthodontics* 2014;27:477-479.
- [17] Berglundh T. Peri-implant diseases and conditions: Consensus report of workgroup 4 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. *Journal of Periodontology* 2018;89: S313-S318.

- [18] . Lindhe J, Berglundh T, Ericsson I, Liljenberg B, Marinello C. Experimental breakdown of peri-implant and periodontal tissues. A study in the beagle dog. *Clin Oral Implants Res* 1992;3:9-16.
- [19] Esposito MH. Biological factors contributing to failures of osseointegrated oral implants,(I). Success criteria and epidemiology. *European Journal of Oral Sciences* 1998;106(1):527-551.
- [20] Wood MR, Vermilyea SG, Committee on Research in Fixed Prosthodontics of the Academy of Fixed Prosthodontics. A review of selected dental literature on evidence-based treatment planning for dental implants: Report of the committee on research in fixed prosthodontics of the academy of fixed prosthodontics. *J Prosthet Dent* 2004;92:447-62.
- [21] Moy PK, Medina D, Shetty V, Aghaloo TL. Dental implant failure rates and associated risk factors. *Int J Oral Maxillofac Implants* 2005;20:569-77.
- [22] Brocard D, Barthet P, Baysse E, Duffort JF, Eller P, Justum P, et al. A multicenter report on 1,022 consecutively placed ITI implants: A 7-year longitudinal study. *Int J Oral Maxillofac Implants* 2000;15:691-700.
- [23] Strietzel FP, Reichart PA, Kale A, Kulkarni M, Wegner B, Kuchler I. Smoking interferes with the prognosis of dental implant treatment: A systematic review and meta-analysis. *J Clin Periodontol* 2007;34:523-44.
- [24] Santana RB, Xu L, Chase HB, Amar S, Graves DT, Trackman PC. A role for advanced glycation end products in diminished bone healing in Type 1 diabetes. *Diabetes* 2003;52:1502-10.
- [25] Hwang D, Wang HL. Medical contraindications to implant therapy: Part II: Relative contraindications. *Implant Dent* 2007;16:13-23.
- [26] Wang HL, Weber D, McCauley LK. Effect of long term oral bisphosphonates on implant wound healing: Literature review and a case report. *J Periodontol* 2007;78:584-94.
- [27] Ruggiero SL, Mehrotra B, Rosenberg TJ, Engroff SL. Osteonecrosis of the jaws associated with the use of bisphosphonates: A review of 63 cases. *J Oral Maxillofac Surg* 2004;62:527-34.
- [28] Becker ST, Terheyden H, Steinriede A, Behrens E, Springer I, Wiltfang J. Prospective observation of 41 perforations of the Schneiderian membrane during sinus floor elevation. *Clin Oral Implants Res* 2008;19:1285-9.
- [29] Peleg M, Garg AK, Mazor Z. Predictability of simultaneous implant placement in the severely atrophic posterior maxilla: A 9-year longitudinal experience study of 2132 implants placed into 731 human sinus grafts. *Int J Oral Maxillofac Implants* 2006;21:94-102.
- [30] van Steenberghe D, Jacobs R, Desnyder M, Maffei G, Quirynen M. The relative impact of local and endogenous patient-related factors on implant failure up to the abutment stage. *Clin Oral Implants Res* 2002;13:617-22.
- [31] Mealey BL. Periodontal implications: Medically compromised patients. *Ann Periodontol* 1996;1:256-321.
- [32] Granström G, Tjellström A, Brånemark PI. Osseointegrated implants in irradiated bone: A case-controlled study using adjunctive hyperbaric oxygen therapy. *J Oral Maxillofac Surg* 1999;57:493-9.
- [33] Givol N, Chaushu G, Halamish-Shani T, Taicher S. Emergency tracheostomy following life-threatening hemorrhage in the floor of the mouth during immediate implant placement in the mandibular canine region. *J Periodontol* 2000;71:1893-5.
- [34] Dumont RJ, Ensom MH. Methods for clinical monitoring of cyclosporin in transplant patients. *Clin Pharmacokinet* 2000;38:427-47.
- [35] Leite MF, Santos MC, de Souza AP, Line SR. Osseointegrated implant failure associated with MMP-1 promoter polymorphisms (-1607 and -519). *Int J Oral Maxillofac Implants* 2008;23:653-8.
- [36] Goodacre CJ, Kan JYK, Rungcharassaeng K. Clinical complications of osseointegrated implants. *J Prosthet Dent* 1999; 81:537-52.
- [37] . Duncan JP, Nazarova E, Vogiatzi T, et al. Prosthodontic complications in a prospective clinical trial of single-stage implants at 36 months. *Int J Oral Maxillofac Implants*. 2003; 18(4):561-5.
- [38] Karl M, Taylor TD, Wichmann MG, et al. In vivo stress behavior in cemented and screw-retained five-unit implant FPDs. *J Prosthodont*. 2006; 15(1):20-4.
- [39] Monasky GE, Taylor DF. Studies on the wear of porcelain, enamel, and gold. *J Prosthet Dent* 1971; 25(3): 299-306. .

- [40] Balshi TJ. An analysis and management of fractured implants: A clinical report. *Int J Maxillofac Implants* 1996; 11:660-66.
- [41] Purcell BA, McGlumphy EA, Holloway JA, et al. Prosthetic complications in mandibular metal-resin implant-fixed complete dental prostheses: a 5- to 9-year analysis. *Int J Oral Maxillofac Implants*. 2008; 23(5):847- 57.
-

