Dental Implants Placed from 2002-2009 in an Advanced Specialty Education Program in Periodontics: A Radiographic and Clinical Review

Lisa A. Frisbie-Teel, DDS

A thesis submitted for the degree of
Master of Science in Periodontology

Oregon Health & Science University
Portland, Oregon

April 9, 2012

Dental Implants Placed from 2002-2009 in an Advanced Specialty Education Program in Periodontics: A Radiographic and Clinical Review

Lisa A. Frisbie-Teel, DDS

Master of Science in Periodontology Research Advisory Committee:

Signature: _____ Date: _____

Steven Hokett, D.D.S., M.C.R.
Assistant Professor
Department of Periodontology
Oregon Health & Science University

Signature: _____ Date: _____

Thomas J. Hilton, DMD, MS
Alumni Centennial Professor in Operative Dentistry
Oregon Health & Science University

Signature: _____ Date: _____

Tom Maier, Ph.D.
Assistant Professor
Department of Integrative Biosciences
Oregon Health & Science University

Signature: _____ Date: _____

J. Ernest Weinberg, DMD, MSD
Associate Professor
Department of Periodontology
Oregon Health & Science University

Acknowledgements

First and foremost, I would like to thank my husband, Jared Frisbie-Teel, D.D.S. for his immeasurable love and support during this project and throughout all my endeavors.

In addition, I would like to thank the following individuals for their contributions and support of this project:

Thesis Committee Members

Donald F. Adams, D.D.S., M.S.

Winthrop B. Carter, D.D.S., F.I.C.D.

Yong-Geun Choi, D.D.S., M.P.H, M.P.H.

Joseph M. Haynes, D.D.S.

Research assistants (2012 D.M.D. candidates) :

- Kathleen Rock
- Mike Sparrow
- Alex Vo

Luzviminda Tulipat, D.M.D.

In Memory of

R. Douglas Teel, D.D.S.

This research project and my professional pursuits are dedicated to the memory of my extraordinarily valiant, immeasurably wise, brilliant, and beloved father.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Abstract

Background: The adoption into mainstream dental therapy of endosseous dental implants manufactured from medical grade titanium has revolutionized the treatment of edentulous sites while demonstrating excellent success and survival percentages. Few studies have evaluated dental implant survival or success within a university residency program. There are even fewer studies that have analyzed implant outcomes by radiographic survey. The primary objectives of this study were to evaluate survival and success of dental implants placed by periodontal residents at Oregon Health & Science University (OHSU) between the years 2002 and 2009 and to assess residual bone height as assessed radiographically, around these implants. A novel radiographic parameter described as dental implant radiographic residual bone height (DIRRBH) is utilized as a measurement of dental implant success. Measurement of dental implant radiographic crestal bone loss (DIRCBL)is also assessed in this study.

Secondary aims of this study included determining if various demographic and patient health parameters or if the residency year of the surgeon placing the implant fixture(s) may affect DIRRBH or dental implant survival.

Methods: A retrospective clinical chart review was conducted of patients of record at OHSU School of Dentistry who had one or more implants placed by periodontal residents from 2002-2009. Subjects were contacted and invited to participate in a recall examination. During the recall examination clinical assessment of the restored dental implants, a single digital periapical radiograph was taken of each dental implant. Patient

demographic, health, and dental implant data were recorded from the chart review and verified during the clinical appointment. An anonymous survey was conducted of all participants in order to evaluate patient satisfaction with the dental implant experience and the final result. Radiographs were then analyzed by two calibrated and independent evaluators. Statistical data analysis was performed using the cox proportional hazard regression model and Kruskal Wallis test. Results were considered significant where the $P < 0.05$.

Results: The case series included 79 patients with 167 dental implants that had been placed. The post-implant placement mean follow-up period was 5.11 years with a range of two to nine years. The study population consisted of 56% female and 44% male subjects. Subject age ranged from 17 years to 85 years, with a mean age of 60.3 years. Implant lengths ranged from 6 to 16 millimeters, with a median length of 11.5 millimeters.

Dental implant radiographic residual bone height (DIRRBH) as dental implant fixture length was 90.7%. Females retained a mean of 90% and males 91%; healthy patients retained 91% while diabetics retained 88% of the DIRRBH per dental implant fixture length. DIRRBH per dental implant fixture length was 91% for never smokers. Current and historical smokers retained 89.4 and 89.6%, respectively. Cumulative average radiographic crestal bone loss on the dental implant fixture was 1.03 millimeters ($s = 0.882$; range 0 – 5.5). Cumulative survival rate over the nine year period was 96.8%.

Conclusion: This study reports that endosseous dental implants placed from 2002-2009 achieve survival rates achieved are consistent with accepted published results for dental implant survival. Age, gender, diabetes, smoking, osteoporosis, osteopenia do not significantly affect the combined DIRRBH or overall dental implant survival. There was slightly less non-significant DIRRBH for dental implants placed in diabetics and smokers. Finally, the level of experience of the periodontal resident did not affect dental implant survival in this study.

Introduction

The widespread adoption of treating edentulous sites with endosseous dental implants manufactured from medical grade titanium has revolutionized restorative dentistry. Dental implants have become the gold standard treatment option for tooth replacement [1] and will continue to increase in popularity as the world population ages and patient expectations increase for an improved quality of dental function into advancing age. Dental patients increasingly demand highly successful and predictable long-term treatment that satisfies both esthetic dental display and excellent function. [2] The published survival rates for all endosseous dental implants averages well above 90% [3,4,5,6,7] and patient satisfaction is high. [8,9]

Dental implant success is often measured by the absence of pain, mobility or radiographic pathology along with dentist and patient satisfaction with the esthetics and function. The maintenance of stable bone levels around dental implants is also believed to be essential for the long-term success of an endosseous dental implant. The initial breakdown of the tissue-implant interface in successfully osseointegrated implants typically begins at the alveolar crestal region.[10,11] Periimplant crestal bone is also quite thin, often one millimeter or less, which may then predispose the site to subsequent loss[12] This crestal peri-implant bone loss may also be due to the fact that the peri-implant gingiva does not attach directly to the implant titanium surface but forms what is known as a 'perimucosal seal'. Crestal peri-implant bone loss may be greatest during the first year of function and is reported to be 1.2 mm on average.[3,13]

One of the most important criteria when evaluating dental implant success is determining the stability of crestal bone levels surrounding an implant over time. Albrektsson, *et al.*[14] and Smith and Zarb[15] proposed criteria for implant success, including a peri-implant crestal bone loss of less than 0.2 mm annually. There are many proposed causes for crestal peri-implant bone loss[16] including: surgical trauma[17-20], occlusal disharmony, overloading of the implant[21-24], peri-implantitis[25,26] and proximity of the microgap (healing or final abutment to implant platform interface) to peri-implant crestal bone[27,28]. Peri-implant inter-dental crestal bone loss can be detected by dental radiograph. In order for a dental implant to survive in bone, the residual bone height around a dental implant must be maintained over time. Classically, and in this study, dental implant survival is defined as the implant remaining *in situ* at the end of an observation period. Modern clinical success of a restored dental implant also includes the absence of pain, mobility or radiographically-evident periimplant pathology as well as meeting patient esthetic and functional expectations.

We introduce a novel positive marker for dental implant success called the dental implant radiographic residual bone height (DIRRBH). The definition for dental implant success in this study includes excellent radiographic and clinical implant integration along with patient and practitioner satisfaction with the restored dental implant.

Endosseous dental implant success rates may also be modified by various systemic, local or operative factors. This study evaluates several of these factors and their association with implant bone height and success. Host systemic factors, including the presence or history of smoking, diabetes, osteopenia and osteoporosis were analyzed. Demographic factors evaluated include age and gender. Operative factors

include the experience year of the resident performing the surgery, the year of dental implant placement and the procedure being performed in an academic setting.

A significant portion of the United States population with missing teeth could benefit from dental implant treatment.[1,2] Dental implant surgical services provided through the academic setting may open a treatment modality to a broader population that would normally be unable to afford implants in the private practice setting. Postdoctoral training in endosseous dental implant placement is now a standard part of the curriculum for periodontology and oral and maxillofacial surgery residency programs. In addition, many prosthodontic and other dental specialty training programs also offer training in the placement of dental implants to their residents.[29]

Even so, there are few studies evaluating the success and survival of dental implants placed in the academic setting. Most reports of dental implant placement in the academic setting are retrospective chart reviews without clinical recall, radiographic assessment or accounts of patient satisfaction.

The primary objectives of this study were to evaluate comprehensive dental implant survival and success rates of implants placed by periodontal residents at OHSU in the years 2002 through 2009 and to assess radiographic bone height around these dental implants. Secondary aims of this study include determining whether patient demographic and health parameters or the residency year of the dental implant surgeon affects subsequent radiographic bone height around or dental implant survival .

Material and Methods

This study was approved by the Institutional Review Board at OHSU. A preliminary retrospective chart review and subsequent clinical and radiographic clinical examination were conducted of patients with dental implants that were placed by periodontology residents at OHSU during the calendar years of 2002 through 2009.

Study subjects were between the ages of 18 and 89 years old at recall and had dental implant restorations in place for at least one year. All dental implants were placed such that the restorative platform was located at the height of crestal bone as verified by patient treatment records. Final restorations were performed by dental students, residents or private general dentists. Patient records identified as meeting the indicated criteria were surveyed and subjects who met the inclusion criteria were invited to participate in a screening appointment. A total of 799 patients were treated in the Graduate Periodontology Clinic at OHSU with 1,815 dental implants placed during the years 2002 to 2009. 207 subjects were subsequently contacted by telephone to participate in a recall examination.. Finally, 79 patients (n=167 implants) actually participated in the study.

Retrospective Data Collection

A post-entry chart review was conducted of demographic data including patient age, gender and medical and social history (smoking, diabetes, and osteoporosis or osteopenia). Dental implant placement information including: The number and sites of dental implants placed, the year the implant was placed, implant size and manufacturer, and periodontal resident year at time of placement were collected.

Clinical Assessment

Patient consent for a limited implant examination was obtained once the subject agreed to be in the study. During the recall appointment a visual assessment and digital palpation of the dental implant fixture were performed by a single examiner (LAFT); including surveying for absence of persistent clinical symptoms such as pain, mobility, infection, neuropathies or paresthesias. An interview was conducted to determine patient comfort, functional satisfaction and esthetic acceptance.

Questionnaire

An anonymous intake questionnaire (Figure 1) was conducted to assess each patient's satisfaction with their dental implant and whether the subject had any discomfort related to the dental implant. This questionnaire was conducted by logistics personnel independent of the clinical assessment team and prior to the patient's clinical assessment.

Radiographic Evaluation and Interpretation

A single digital periapical radiograph was taken of each dental implant fixture. (Figure 2,3) Periapical radiographs were taken with a long-cone parallel technique using a standard intraoral occlusal template to assist in the projection of a perpendicular radiation beam. Peri-apical radiographs that captured the apex of the implant are necessary in order to rule out the presence of any peri-implant radiolucency, one criterion of dental implant success as defined in this study. The periapical radiograph was used to detect the presence of any peri-implant radiolucency, periapical radiolucency on adjacent teeth and the interproximal crestal bone height.

Study radiographs were assessed by two independent calibrated examiners utilizing computer software (Emago dental image archiving software 2011) to calibrate each radiograph using the known dental implant fixture length to determine both DIRCBL and DIRRBH. Patient treatment records indicated that all dental implant fixture platforms were placed at the existing height of the edentulous alveolar bone. The marginal bone level was considered the point represented by the radiographic interpretation of the most coronal portion of the interproximal (adjacent) bone in contact with the implant. The existing marginal bone level was measured on the mesial and distal of each implant and was averaged, resulting in the % DIRRBH of each dental implant. DIRRBH measurements from examiners (were averaged to determine the % DIRRBH of each implant.)

Dental implant radiographic crestal bone loss (DIRCBL) was determined as the measurement from the dental implant platform to the proximal radiographic crest of bone. (Figure 4) DIRRBH was measured as the radiographic distance from the implant apex to the proximal radiographic bone height. (Figure 5) Peri-implant DIRRBH of trans-gingival implants was calculated from the implant apex to the rough-smooth border as interpreted by the calibrated examiners. Patient clinical and radiographic information, as well as the patient survey results, were stored in a spreadsheet and matched with the information collected from the retrospective patient record chart review.

Study Variables

A standardized digital data collection form was designed and used for all patients in the study. The information recorded included the following information: Patient demographic data (birthdate, gender), and information regarding patient health

(smoking history, past and current systemic diseases, including diabetes, osteoporosis and osteopenia), as well as data for the specific implant (tooth number, implant manufacturer, date of implant placement, implant dimensions, bone/tissue grafting, stage, and type of restoration placed). The year of the periodontal resident surgeon was also recorded.

In our study, dental implant success is defined as:

1.) Dental implant remains *in situ* and is immobile

2.) No evidence of peri-implant radiolucency, except crestal bone loss

3.) No irresolvable pain, discomfort, or infection attributable to the implant

4.) Patient satisfaction with esthetics and function of the dental implant.

5.) DIRRBH is greater than 75% of dental implant length.

Implant survival is defined as the implant remaining *in situ* within the alveolus.

Statistical Analysis

Cox proportional hazard regression model was conducted for testing the statistical significance of difference of implant survival based on smoking history, diabetes, osteoporosis, and osteopenia after adjusting for the potential confounding effect of age and gender. A Kruskal Wallis test was performed for testing the statistical significance of differences in DIRCBL and DIRRBH on the mesial and distal aspects according to age, gender, smoking history, diabetes, osteoporosis, and osteopenia. Linear relationship (r^2) between age and implant length was estimated with simple linear regression. Software used for the analysis was JMP 5.0.1 (SAS Institute, Cary, NC). *P*-value of less than .05 was established as the threshold for statistical significance. The mean age and gender of the 79 subjects who received the 167 implants included in the

study were compared to the 799 individuals who received 1,815 implants at the OHSU Department of Periodontology in the years 2002-2009 at the 95% confidence interval to judge how well the study sample represented the overall population of individuals receiving implants.

Results

The study population of 79 patients with 167 dental implants had a mean follow-up period of 5.11 years from implant placement with a range of two to nine years. The study population consisted of 56% female and 44% male. The ages of subjects ranged from 17 to 85 years; mean of 60.3 years. Implant lengths ranged from 6 to 16 millimeters, with a median of 11.5 millimeters. A total of 79 out of 799 patients (n=167 implants) participated in the study (38.2%) The most common reason that patients randomly selected for recall invitation were lost to recall follow-up was due to relocation or lack of current contact information. The demographic and implant-specific data of all subjects is displayed in Table 1.

To ensure that the final study sample was representative of the population who received the 1815 implants; mean age and gender of the 79 patients who had received the 167 sample implants versus the 799 patients who were treated with 1,815 implants were compared. Table1-1 shows that mean age and gender proportion of the population implants are within ($\subset$) the 95% CI of the sample. (Table 2) Thus, those who participated are very likely to be a representative sample.

Combined dental implant radiographic residual bone height (DIRRBH) was 90.7%. DIRRBH was found to be 90% in females and 91% in males. Healthy patients retained 91% bone height, while diabetics retained 88% of the combined DIRRBH.

Combined DIRRBH was 91% for never smokers however current and historical smokers were at 89.4 and 89.6% respectively (p-value=0.7417). Cumulative average radiographic crestal bone loss on the dental implant fixture was 1.03 millimeters (s = 0.882; range 0 – 5.5).

A successful outcome for all dental implants placed in this study according to the criteria was 95.8%. Cumulative dental implant survival rate over the nine year period was 96.8%. (Table 3)

Discussion

The primary aim of this study is to determine cumulative dental implant survival of implants placed by periodontal residents at OHSU between the years 2002 and 2009. The overall cumulative dental implant survival rate for the study population was 96.8%. This appears to fall within published standards of acceptable survival rates for dental implants placed in both private practice[30,31] and academic settings.[6,7]

Dental implant crestal bone height changes have been traditionally evaluated retrospectively by the amount of dental implant radiographic crestal bone loss (DIRCBL).[3]This study introduces the corollary term of *dental implant radiographic residual bone height* (DIRRBH) as a measure of dental implant success. DIRRBH represents, radiographically, the bone around a dental implant fixture as a percentage of the dental implant fixture length at any given observation time. This “glass half-full” concept of evaluating residual peri-implant bone height may provide clinicians with an easy tool to assess dental implant stability during implant recalls. We also propose that DIRRBH greater than 90% of dental implant length indicates a excellent dental implant

success while a minimally acceptable standard of dental implant success would be represented by a DIRRBH of 75%.

We also assessed various health and demographic parameters to determine whether their presence affected overall dental implant survival rate. Patient health metrics in this study included an evaluation for the presence of diabetes, osteoporosis, osteopenia or a history of cigarette smoking. Diabetes and smoking are strong co-factors for dental implant failure, [32-34] however these did not show a significant relationship to dental implant bone height changes or survival rates in our study. There was slightly less dental implant radiographic residual bone height (DIRRBH), however for dental implants placed in diabetics and smokers. One possible explanation for the fact that diabetes did not have a statistically significant deleterious effect on crestal bone height is that as a pre-requisite, diabetics who undergo implant therapy (in OHSU's Department of Periodontology) must be tightly controlled (serum glycemic level and hemoglobin A1c in normal ranges.[35]) Therefore, the study would not include patients who are considered uncontrolled diabetics. In a systematic review of the literature, Javed *et al.,* concluded that successful dental implant osseointegration can be accomplished in diabetics with good metabolic control in a similar manner as in subjects without diabetes.[36] Smoking is considered to be a significant risk factor for implant failure.[37,38] Bain and Moy[39] evaluated factors that may predispose implant failure in a group of 540 subjects and found that smoking was the most significant factor. Studies have demonstrated that patients who follow a smoking cessation protocol prior to and following implant placement may experience improved dental implant success rates.[41] An explanation for why smoking did not demonstrate a significantly negative impact on

bone height in our study may be due to the smoking cessation protocol patients follow at our university. Patients are asked to arrest smoking two weeks prior and ten weeks after implant placement. Blood plasma cotinine levels are an objective, albeit unwieldy way to prove that patients are in tobacco cessation compliance and should decrease the likelihood of initial periimplant bone loss. [42] Furthermore, there was no significant difference when looking at survival rate or DIRRBH in relationship to age and gender.

Residency year of the surgeon placing the implant fixtures did not affect the DIRRBH or survival of dental implants. In this study, most of the implants were placed by second and third year residents. First year residents placed only ten out of the 167 implants, therefore this may limit the ability of this study to assess whether resident year affects outcomes of dental implants.

This is an uncontrolled retrospective case series designed to assess implant survival and success criteria. There are several evident limitations to the study including the retrospective study design and a small sample size. The small sample size, which is representative of less than 10% of all the implants placed in the department between the years 2002 and 2009. This loss to follow-up of the treatment population is the primary weakness of this study design. In addition, this study evaluates dental implants that were restored by private practitioners, residents, and dental students. This study does not evaluate whether there is an association between the timing and practitioner experience of the implant restoration following surgical placement and an implant's ultimate survival or success rate. Future large-scale prospective university studies should be conducted that include annual dental implant recalls to evaluate and

document implant health, restorative source and temporal sequence would be helpful to better determine potential surrogate markers for future dental implant success.

Conclusions

1.) The cumulative survival rate of 96.8% and success rate of 95.8% for dental implants placed at Oregon Health and Science University's Advanced Education Program in Periodontics is within accepted published standards.

2.) Age, gender, diabetes, smoking, osteoporosis, and osteopenia did not significantly affect the combined dental implant radiographic residual bone height (DIRRBH) or the overall survival of the dental implants evaluated in this study.

3.) There was slightly less DIRRBH associated with dental implants placed in diabetics and smokers, however the difference was not significant.

4.) The level of experience of the periodontic resident did not have an impact on dental implant survival in this study.

References

1. Stillman N, Douglass CW. The developing market for dental implants. J American Dent Assoc 1993;124:51–56.
2. Davis B.K, Dental Aesthetics and the Aging Patient (2006). Facial Plastic Surgery. 22(2):154-160.
3. Adell R, Eriksson B, Lekholm U, et al. T. Long-term follow-up study of osseointegrated implants in the treatment of totally edentulous jaws. Int J Oral Maxillofac Implants 1990;5:347-359.
4. Lekholm U, Gunne J, Henry P, et al. Survival of the Branemark implant in partially edentulous jaws: A 10-year prospective multicenter study. Int J Oral Maxillofac Implants 1999;14: 639-645.
5. Buser D, Mericske-Stern R, Bernard JP, et al. Long-term evaluation of non-submerged ITI implants. Part 1: 8-year life table analysis of a prospective multi-center study with 2359 implants. Clin Oral Implants Res 1997;8:161-172.
6. Zupnik J, Kim S, Ravens D, Karimbux N, Guze K, Factors Associated With Dental Implant Survival: A 4-Year Retrospective Analysis. J. Periodontol, 2011, Vol. 82, No. 10, Pages 1390-1395.
7. Melo M, Shafie H, Obeid G, J Implant Survival Rates for Oral and Maxillofacial Surgery Residents:A Retrospective Clinical Review With Analysis of Resident Level of Training on Implant Survival, Oral Maxillofac Surg 64:1185-1189, 2006.
8. Bakke M, Holm B, Gotfredsen K. , Masticatory function and patient satisfaction with implant-supported mandibular overdentures: a prospective 5-year study. Int J Prosthodont. 2002 Nov-Dec;15(6):575-81.

9. Cochran D, Jackson J, Jones A, Jones J, Kaiser D, Taylorn T, Weber H P, Higginbottom F, Richardson J, Oates T, A 5-Year Prospective Multicenter Clinical Trial of Non-Submerged Dental Implants With a Titanium Plasma-Sprayed Surface in 200 Patients,J. Periodontol, Jul 2011, Vol. 82, No. 7, Pages 990-999.
10. Adell R, Lekholm U, Rockler B, Branemark P-I. A 15- year study of osseointegrated implants in the treatment of the edentulous jaw. Int J Oral Surg 1981; 10: 387-416.
11. Berglundh T, Lindhe J, Dimension of the periimplant mucosa. Biological width revisited. J Clin Periodontol 1996;23:971-973.
12. Berglundh, T. and Lindhe, J. (1996), Dimension of the periimplant mucosa. Journal of Clinical Periodontology, 23: 971–973.
13. Bauman GR, Mills M, Rapley J, et al. Clinical parameters of the evaluation during implant maintenance. Int J Oral Maxillofac Implants. 1992;7:220-227.
14. Albrektsson T, Zarb D, Worthington P, Eriksson RA. The long-term efficacy of currently used dental implants: a review and proposed criteria of success. Int J Oral Maxillofac Implants 1986; 1:11-25.
15. Smith DE, Zarb GA. Criteria for success of osseointegrated endosseous implants. J Prosthet Dent 1989; 62:567-572.
16. Oh T, Yoon J, Misch C, Wang H. The Causes of Early Implant Bone Loss: Myth or Science? J. of Periodontol Mar 2002, Vol. 73, No. 3, Pages 322-333: 322-333.
17. Branemark P-I, Adell R, Breine U, Hansson BD, Lindstrom J, Ohlsson A. Intra-osseous anchorage of dental prostheses. Scand J Plast Reconstr Surg 1969; 3:81-100.

18. Albreksson T. Bone tissue response. In: Branemark P-I, Zarb GA, Albreksson T, eds. Tissue-Integrated Prostheses. Chicago: Quintessence Publishing Co.; 1985: 129-143.
19. Esposito M, Hirsch JM, Lekholm U, Thomsen P. Biological factors contributing to failures of osseointegrated oral implants. (II) Etiopathogenesis. Eur J Oral Sci 1998: 106721-764.
20. Sharawy, M., C. E. Misch et al. (2002). Heat generation during implant drilling: the significance of motor speed. J Oral & Maxillofacial Surgery 60(10): 1160-1169.
21. Quirynen M, Naert I, van Steenberghe D. Fixture design and overload influence marginal bone loss and fixture success in the Branemark system. Clin Oral Implant res 1992;3:104-111.
22. Tonetti MS, Schmid J. Pathogenesis of implant failures. Periodontology 2000 1994;4:127-138.
23. Isidor F. Loss of osseointegration caused by occlusal load of oral implants. A clinical and radiographic study in monkeys. Clin Oral Implant Res 1996;7:143-152.
24. Isidor F. Histological evaluation of peri-implant bone at implants subjected to occlusal overload or plaque accumulation. Clin Oral Implant Res 1997;8:1-9.
25. Becker W, Becker BE, Newman MG, Nyman S. Clinical and microbiologic findings that may contribute to dental implant failure. Int J Oral Maxillofac Implants 1990: 5:31 -38.
26. Hemant Kumar Gupta, et al, Peri-implantitis: A Risk Factor In Implant Failure, Journal of Clinical and Diagnostic Research. 2011 Feb, Vol-5(1):138-141.

27. Hermann JS, Cochran DL, Nummikoski PV, Buser D. Crestal bone changes around titanium implants. A radiographic evaluation of unloaded nonsubmerged and submerged implants in the canine mandible.J Periodontol 1997;68:1117-1130.
28. Broggini N, McManus LM, Hermann JS, et al. Persistent acute inflammation at the implant-abutment interface. J Dent Res 2003;82:232-237
29. Barber HD, Betts NJ, Edwards ML. The status of implant training in oral and maxillofacial surgery residency programs. J Oral Maxillofac Surg 1994;52:1058–1060.
30. Wagenberg B, Froum SJ, A retrospective study of 1925 consecutively placed immediate implants from 1988 to 2004 Int J Oral Maxillofac Implants. 2006 Jan-Feb;21(1):71-80.
31. Nixon KC, Chen ST, Ivanovski S, A retrospective analysis of 1,000 consecutively placed implants in private practice, Aust Dent J. 2009 Jun;54(2):123-9.
32. Weyant RJ. Characteristics associated with the loss and peri-implant tissue health of endosseous dental implants. Int J Oral Maxillofac Implants 1994;9:95-102.
33. Bergstrom J, Preber H. Tobacco use as a risk factor. J Periodontol 1994;65:545-550.
34. Fiorellini JP, Chen PK, Nevins M, Nevins ML. A retrospective study of dental implants in diabetic patients. Int J Periodontics Restorative Dent 2000;20:366-373.
35. Sacks D, Bruns D, Goldstein D, et al. Guidelines and recommendations for laboratory analysis in the diagnosis and management of diabetes mellitus. Clin Chem. 2002;48:436-472.

36. Fawad Javed, George E. Romanos, Impact of Diabetes Mellitus and Glycemic Control on the Osseointegration of Dental Implants: A Systematic Literature Review, J Periodontol, Nov 2009, Vol. 80, No. 11: 1719-1730.
37. Chuang SK, Wei LJ, Douglass CW, Dodson TB, Risk Factors for dental implant failure. A strategy for the analysis of clustered failure-time observations. J Den Res 2002; 81: 572-577
38. De Bruyn H, Collaert B. The effect of smoking on early implant failure. Clin Oral Impl Res 1994;5:260-264.
39. Bain CA, Moy PK. The association between the failure of dental implants and cigarette smoking. Int J Oral Maxillofac Implants 1193;8:609-615.
40. Bain CA, Smoking and implant failure--benefits of a smoking cessation protocol., Int J Oral Maxillofac Implants. 1996 Nov-Dec;11(6):756-9.
41. César-Neto JB, Benatti BB, Sallum EA, Sallum AW, Nociti FH Jr., Bone Filling Around Titanium Implants May Benefit From Smoking Cessation: A Histologic Study in Rats, J Periodontol 2005;76:1476-1481.
42. Caraballo RS, Giovino GA, Pechacek TF, et al. Racial and ethnic differences in serum cotinine levels of cigarette smokers: Third National Health and Nutrition Examination Survey, 1988-1991. JAMA 1998; 280:135-139.

FIGURES

Figure 1 Implant Satisfaction Questionnaire

Please mark a single answer.

	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
My implant is comfortable.					
I am pleased with the esthetic results (the way it looks) of my implant.					
I can chew on my implant prosthesis very well.					
The tissue around the implant bleeds less than around the teeth.					
I haven't felt uncomfortable because of food packing during chewing.					
I can speak well with my implant prosthesis.					
I am satisfied with my implant prosthesis.					
My implant(s) has improved my quality of life.					
If needed, I would choose to have a dental implant in another area of my mouth					
I have been satisfied with the treatment I've received at the Advanced Specialty Program in Periodontics at OHSU.					

Figure 2

Implant #7: 0mm DIRCBL; 100% DIRRBH

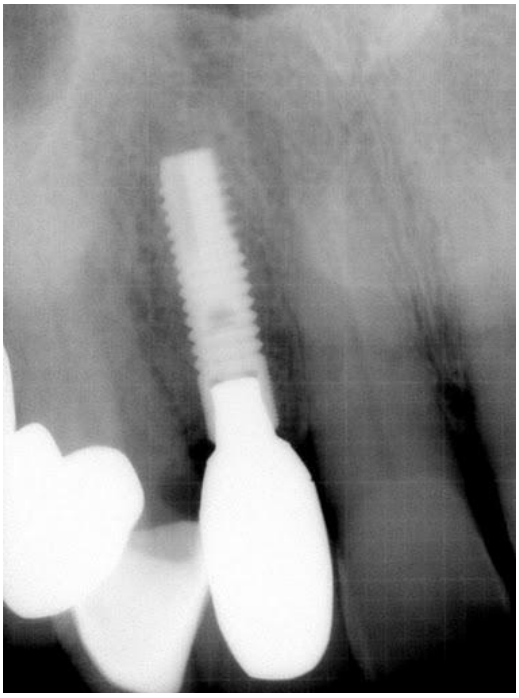


Figure 3

Implant #30 (Distal implant): 2.2 mm DIRCBL; 78% DIRRBH

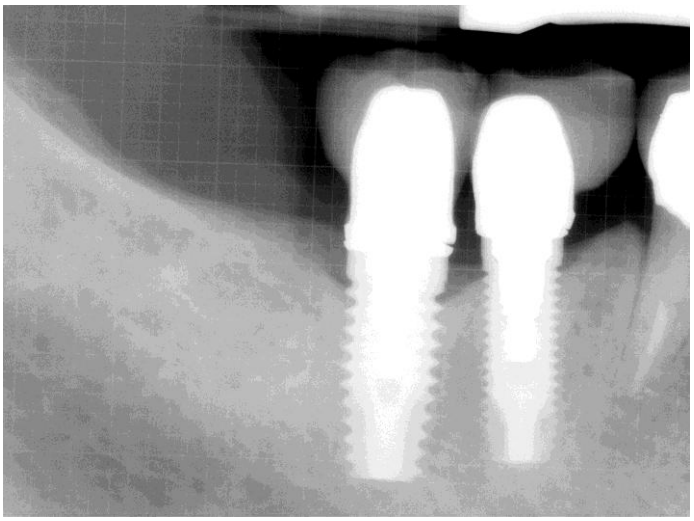


Figure 4

DIRCBL: Measurement from the dental implant platform (A) to proximal radiographic crest of bone (B) calculated as height in mm.

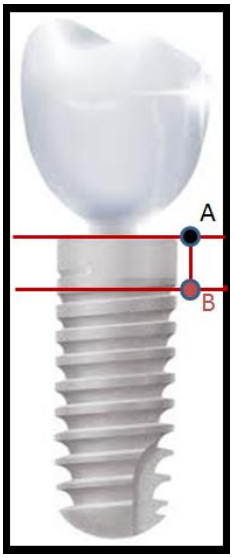
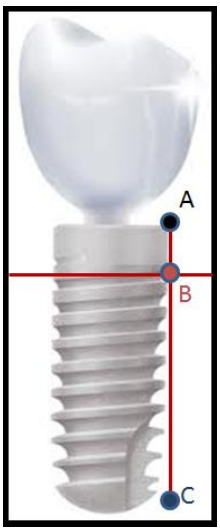


Figure 5

DIRRBH: Measurement from the implant apex (C) to the proximal radiographic bone height (B) and calculated as a % of the implant platform (A) to the implant apex (C)



TABLES

Table 1 Demographic data based on number of implants placed. (n=167)

Age	Mean	60.3
	Min	17
	Max	85
Smoking	Never	130
	Past	35
	Current	2
Diabetes	No	140
	Yes	27
Osteoporosis	Yes	11
	No	156
Osteopenia	Yes	7
	No	160
Implant Type	Tissue Level	10
	Bone Level	157
Gender (based on #of implants)	F	94
	M	73
Resident Year	1	10
	2	73
	3	84

Table 2 Comparison of the sample and the population to evaluate the statistical their similarity.

Variables		Sample (n=167)		Population(n=1791)*	Sample ⊂ population
			95% confidence interval		
Mean age	Male	61	58.2 ~ 63.7	59.7	Yes
	Female	59.8	57.1 ~ 62.4	56.4	Yes
Gender(%)	Male	44	36.4 ~ 51.3	40	Yes
	Female	56	48.7 ~ 63.5	60	Yes

*:Among 1815 implants, 24 implants (1.3%) were excluded due to unknown gender

Table 3 Clinical outcome for survival data based on time since implant placement. (n=167)

Survival time (years)	No. survived at beginning of interval	No. failed at end of interval	Fraction surviving interval (%)	Cumulative Survival Rate(%)
1	167	2	98.8	98.8
2	165	1	99.4	99.2
3	164	1	99.4	98.6
4	163	2	98.8	97.4
5	161	1	99.4	96.8
6	160	0	100	96.8
7	160	0	100	96.8
8	160	0	100	96.8
9	160	0	100	96.8

LITERATURE REVIEW

Search Outcome

A comprehensive Ovid MEDLINE search was performed. The search yielded 34 abstracts.Eleven original articles are included in this review as most pertinent to the present study. Their findings are reviewed below. .

Search Strategy

Results: 33

A literature search of the Ovid MEDLINE(R) and Ovid OLDMEDLINE Databases was conducted for all articles written between 1946 and 2011 containing the following terms:

---

1 exp Dental Implants/ (12486)

2 exp Dental Implantation/ (14964)

3 1 or 2 (21018)

4 exp Treatment Outcome/ (518919)

5 Dental Restoration Failure/ (4643)

6 success.mp. (135944)

7 survival.mp. (646426)

8 failure.mp. (535286)

9 exp survival analysis/ (144116)

10 Retrospective Studies/ (397623)

11 4 or 5 or 6 or 7 or 8 or 9 or 10 (1852330)

12 3 and 11 (5520)

13 Students, Dental/ (4263)

14 Education, Dental/ (12032)

15 Education, Dental, Graduate/ (1625)

16 Education, Dental, Continuing/ (2960)

17 Schools, Dental/ (5228)

18 13 or 14 or 15 or 16 or 17 (20896)

19 exp Surgery, Oral/ (6436)

20 exp Periodontics/ (19775)

21 exp Prosthodontics/ (89556)

22 19 or 20 or 21 (111943)

23 12 and 18 (35)

24 12 and 22 (5520)

25 18 and 24 (35)

26 23 or 25 (35)

Acknowledgement: Dolores Judkins, Head, Instruction, Research & Outreach, Biomedical Information Communications Center, Oregon Health & Sciences University

Articles Included in Review

LITERATURE CITED

1. Farino, et al., Programmatic effectiveness of a university-based implant training program: Long-term, patient-centered outcomes. *Journal of Long-Term Effects of Medical Implants*. 20(4):343-51, 2010.

2. Lee DJ. Harlow RE. Yuan JC. Sukotjo C. Knoernschild KL. Campbell SD, Three-year clinical outcomes of implant treatments provided at a predoctoral implant program, *International Journal of Prosthodontics, 2011 Jan-Feb 24(1):71-6.*

3. Bonde MJ. Stokholm R. Isidor F. Schou S., Outcome of implant-supported single-tooth replacements performed by dental students. A 10-year clinical and radiographic retrospective study., *European Journal of Oral Implantology. 3(1):37-46, 2010.*

4. Hussaini S. Weiner S. Ahmad M., Implant survival rates in a condensed surgical and prosthetic training program for general practitioners in dental implants., *Implant Dentistry. 19(1):73-80, 2010 Feb.*

5. Smith LP. Ng M. Grubor D. Chandu A., Outcomes of dental implants placed in a surgical training programme., *Australian Dental Journal. 54(4):361-7, 2009 Dec.*

6. Chung WE. Rubenstein JE. Phillips KM. Raigrodski AJ., Outcomes assessment of patients treated with osseointegrated dental implants at the University of Washington Graduate Prosthodontic Program, 1988 to 2000., *International Journal of Oral & Maxillofacial Implants. 24(5):927-35, 2009 Sep-Oct.*

7. Andreana S. Beneduce C. Buhite R., Implant success rate in dental school setting: retrospective study., *New York State Dental Journal. 74(5):67-70, 2008 Aug-Sep.*

8. Kronstrom M. McGrath L. Chaytor D., Implant dentistry in the undergraduate dental education program at Dalhousie University. Part 1: clinical outcomes., *International Journal of Prosthodontics. 21(2):124-8, 2008 Mar-Apr.*

9. Maalhagh-Fard A. Nimmo A., Eleven-year report on a predoctoral implant dentistry program., *Journal of Prosthodontics. 17(1):64-8, 2008 Jan*

10. Anweigi LM. Ziada HM. Allen PF., The clinical performance of hybrid bridges delivered by undergraduate dental students: a retrospective study., *Journal of Oral Rehabilitation. 34(4):291-6, 2007 Apr.*

11. Kohavi D. Azran G. Shapira L. Casap N., Retrospective clinical review of dental implants placed in a university training program., *Journal of Oral Implantology. 30(1):23-9, 2004.*