Dental Implants in the Elderly Population: A Long-Term Follow-up

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Purpose: *The objectives of this study were to evaluate implant survival and success in the elderly population and to assess indicators and risk factors for success or failure of dental implants in older adults (aged 60 years and older).* ***Materials and Methods:*** *This historical prospective study was developed from a cohort of patients born prior to 1950 who received dental implants in a single private dental office. Implant survival and marginal bone levels were recorded and analyzed with regard to different patient- and implant-related factors.* ***Results:*** *The study examined 245 patient charts and 1,256 implants from one dental clinic. The mean age at the time of implant placement was 62.18 ± 8.6 years. Smoking was reported by 9.4% of the cohort studied. The overall survival rate of the implants was 92.9%; 7.1% of the implants had failed. Marginal bone loss depicted by exposed threads was evident in 23.3% of the implants. Presenting with generalized periodontal disease and/or severe periodontal disease negatively influenced the survival probability of the implant. Implants placed in areas where bone augmentation was performed prior to or during implant surgery did not have the same longevity compared with those that did not have augmentation prior to implantation.* ***Conclusion:*** *The overall findings concluded that implants can be successfully placed in older adults. A variety of factors are involved in the long-term success of the implant, and special consideration should be taken prior to placing implants in older adults to limit the influence of those risk factors.* Int J Oral Maxillofac Implants 2017;32:164–170. doi: 10.11607/jomi.5305

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Placement of osseointegrated implants is an increasingly common restoration for the replacement of missing teeth. From a single tooth lost to a completely edentulous mouth, implant-supported prostheses can be used as an alternative to traditional bridgework or removable dentures. Implant therapy has proven to be very successful and has profound longevity once osseointegration is achieved.[1–8]

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For the geriatric population, age does not appear to be a factor in the success of implants according to the available literature.[3–5,9,10] Systemic medical conditions that are commonly associated with older age, such as diabetes and osteoporosis, may be a relative contraindication to implant placement due to compromised immune function and lack of bone density.[11,12] However, according to Lee et al, systemic disease is not an issue for implant placement as long as the condition is controlled and specific measures are taken concerning the condition.[11] Specific to diabetes, the survival rate of an implant in well-controlled diabetic patients seems to be as good as in the general population.[13] As for osteoporosis, a literature review done by Dao et al states that there is insufficient literature to substantiate osteoporosis as a risk factor to the osseointegration of dental implants.[14]

Another risk factor concerning the longevity of dental implants is the presence of inflammation in the peri implant tissues. Hoeksema et al studied the peri-implant health of implants in individuals 75 years of age and older and its relation to progressive bone loss around the implant.[15] The study concluded that although plaque and signs of bleeding when probed were present around a large percentage of the implants that were included in the study, it did not seem

to result in an increased amount of bone loss around the implants.[15]

A meta-analysis was conducted in 2014 to determine the significance of periodontitis on the survival rate of implants.[8] The study revealed that periodontitis posed a statistically significant risk on implant success rates.[8,16,17] The meta-analysis concluded that caution should be taken in the placement of dental implants in periodontally involved patients.[8] Furthermore, in a long-term cohort study by Levin et al, 2,336 implants were observed based on the interaction between survival time and specific factors.[17] It was found that patients with severe periodontal disease had an increased risk of implant failure that was eight times higher than that of periodontally healthy patients.[17]

A retrospective study done by Grant and Kraut in 2007 examined 47 implant cases in a geriatric population.[18] Of the 160 implants placed, only one failed to integrate.[18] The authors concluded that dental implants are predictable and can be successfully placed in medically stable geriatric patients.[18] However, this study had limitations due to the small sample size used. Bryant and Zarb compared the survival of implants in adults aged 60 and older to the survival of implants in adults aged 50 and younger.[4] Both groups had high success rates of 92% and 86.5%, respectively, with any failed implants occurring within the first 4 years.[4] The study included data on the longevity of implants for up to 16 years with few failures, demonstrating that osseointegrated implants can be successfully maintained as patients age.[4] Zarb and Schmitt also studied the osseointegration of implants in the geriatric population.[5] Similar results were found with successful osseointegration of implants in the older patients.[5]

Due to limited studies conducted with implants in the geriatric population, this study aimed to examine a larger group of patients over a relatively long time period to investigate correlations with implant failure. The objectives of the present study were to evaluate implant survival and success in the older adult population and to assess indicators and risk factors for success or failure of dental implants in older populations (age 60 years and older).

MATERIALS AND METHODS

This was a historical prospective cohort study that was developed from a cohort of patients born prior to 1950. The convenience sample was selected from a single dental office, and the data were a collection of a continuous recording of patient information that was consistently performed during the last few decades. Three oral maxillofacial specialists at one oral surgery clinic were responsible for the surgical placement of all implants. All the implants were restored by one prosthodontist. Information was collected from patients' charts and recorded on a Microsoft Excel datasheet between June and August 2015. Bone loss and implant survival were the outcome variables that were recorded by two of the authors (D.C. and S.C.). The authors were calibrated prior to the start of the study. This study was approved by the research ethics board of the University of Alberta (Protocol #00055365).

Study Variables Collected from the Charts

Patient variables that were recorded included sex, age, periodontal status, implant location, and fully or partially edentulous status. Explanatory variables regarding the patient's health status included the presence of diabetes, osteoporosis, the combination of diabetes and osteoporosis, and bisphosphonate use. Smoking was another binary variable that was included in the study along with whether the patient presented regularly for scaling and root planing appointments. Implant variables that were included consisted of implant length, surface, dimensions, and type of restoration. Surgical factors recorded were bone augmentation prior to or during implant placement and if the implant was immediately placed in the extraction socket.

Dates were recorded for the following variables: date of implantation, date of last follow-up, if and when peri-implant mucositis was first clinically noted, and date of implant failure when applicable. The implant failure date was considered to be when the implant was removed. An early failure was described as failing prior to implant loading with late failures occurring after loading.

Statistical Analysis

Survival data analysis methods were used to assess the factors associated with implant failure. Kaplan-Meier survival plots were used to identify whether there was a difference between the survival rates of implants within the class of categorical variables used in the study. Univariate analysis was performed first, and this was followed by a multivariate analysis. For the multivariate survival regression model, the marginal Cox Proportional Hazards method was used. This method was developed by Segal and Neuhaus[19] for the classical clustered failure time data, which takes into account the correlation among implants within patients or clusters. Using the ordinary Cox Proportional Hazards method assumes independence of the observations; however, the implants within patients/clusters are correlated measurements and require adjustment to avoid underestimation of the variance and overestimation of the statistical significance. Cox PH assumptions for the model were checked, and it was found that PH assumption was not violated.

Table 1 Fitting Cox PH Models for Implant Failure Data

Variables	Hazard ratio	95% CI for hazard ratio		*P* value
Sex				
Male (R)	1.0000	–	–	–
Female	0.5031	0.4784	0.5289	.0000
Location				
Maxilla (R)	1.0000	–	–	–
Mandible	0.8856	0.8435	0.9297	.0000
Periodontal disease distribution				
Local (R)	1.0000	–	–	–
General	2.5335	2.3702	2.7082	.0000
Augmentation prior to implantation				
No (R)	1.0000	–	–	–
Yes	2.0308	1.9238	2.1437	.0000
Augmentation during implantation				
No (R)	1.0000	–	–	–
Yes	3.0407	2.8927	3.1962	.0000

R = reference level for each variable.

Bone loss was assessed separately as a second outcome variable. Simple linear regression models were used to demonstrate the association between bone loss and different characteristics of the implant. The basic assumptions were checked for the model, and there was no model assumption violation. Data analysis was performed using statistical SPSS version 20 and R version 3.1.3.

RESULTS

The study examined 245 patient charts from one dental clinic; the data of 1,256 implants were recorded. The patient cohort included 43.7% males and 56.3% females. Overall, 9% of the cohort presented with diabetes mellitus, while 11.4% presented with osteoporosis, and 12.7% (31 patients) were receiving bisphosphonate therapy. The mean age at the time of implant placement was 62.18 ± 8.6 years.

Only 12.7% of the patients studied had confirmed regular dental hygiene therapy visits twice annually at the prosthodontist office, while 60.4% of the patients were recorded as not seeing the dental hygienist twice a year. For the remaining patients, periodontal maintenance appointments were unknown. Smoking was reported by 9.4% of the cohort group. The periodontal status of the group varied with 48.6% of patients having no periodontal disease, 9.4% having moderate periodontal disease, and 42% having severe periodontal disease. Approximately half of the cohort was fully edentulous (48.7%) with the remaining patients being partially edentulous.

Placement of dental implants included 38.5% being placed in the maxilla with the remaining 61.5% of implants being placed in the mandible. The majority of the implant sites (85.9%) did not have bone augmentation prior to the implant surgery; 14.5% of the sites required augmentation during the implant surgery, and 11% of the implants were immediately placed in the extraction socket. As approximately half of the patients were edentulous, 44% of the implant restorations were a hybrid type and 16.8% were overdentures. The remaining implant restorations included 19.6% as single crowns, 16.1% implant-supported fixed partial dentures, 1.8% tooth- and implant-supported fixed partial dentures, and 1.0% cantilevered restorations. More than three-fourths of the restorations were screw-retained (77.3%), and the remaining restorations were cemented. The implants had a mean diameter of 4.59 mm and a mean length of 13.9 mm. The overall survival rate of the implants was 92.9%; 7.1% of the implants had failed.

A clinical diagnosis of peri-implant mucositis was noted for 6.6% of the implants. Marginal bone loss depicted by exposed threads was evident in 23.3% of the implants; 10.5% were seen to have minimal bone loss of 1 to 2 mm, and 12.8% revealed radiographic evidence of bone loss involving 2 mm or more. Patient health–related variables, ie, diabetes, smoking, and osteoporosis, were not found to be statistically related to implant survival and marginal bone loss in the univariate analysis and in the multivariate analysis.

Table 1 presents the hazard ratios for the survival rate of dental implants and the variables: sex, implant location, periodontitis distribution, and bone augmentation.

Table 2 shows the cross tabulation of marginal bone loss by implant location, periodontal distribution, implant surface, bone augmentation, time of implant placement, incidence of peri-implantitis, status of dentition, and the type of restoration. The correlation between the type of implant surface, time of implant placement, and incidence of peri-implantitis was found to be statistically significant ($P < .01$).

Figure 1 demonstrates the correlation between marginal bone loss and the diameter of the implant. The linear regression value of 0.647 indicated that a wider diameter of the implant is associated with increased bone loss. The relationship between implant failure and a patient's periodontal status and distribution is illustrated in Fig 2. Presenting with generalized periodontal disease and/or severe periodontal disease negatively influenced the survival probability of the implant. Figure 3 demonstrates the association between implant failure and bone augmentation. Implants placed in areas where bone augmentation was performed prior to implant surgery did not have the same longevity compared with those implant sites that did not have augmentation prior to implantation. Implantations where

Table 2 Cross Tabulation and Chi-Square Test for Marginal Bone Loss Implant Characteristics

Implant characteristics	Marginal bone loss			Chi-square value	*P* value
	No (%)	Moderate (%)	Severe (%)		
Implant location				4.330	.115
Maxilla	378 (78.3)	40 (8.3)	65 (13.5)		
Mandible	583 (75.5)	92 (11.9)	95 (12.3)		
Periodontal distribution				4.425	.352
Local	223 (80.8)	27 (9.8)	26 (9.4)		
General	227 (76.1)	40 (11)	47 (12.9)		
Unknown	461 (75.2)	65 (10.6)	87 (14.2)		
Augmentation prior to implantation				3.112	.211
No	834 (77.5)	111 (10.3)	131 (12.2)		
Yes	127 (71.8)	21 (11.9)	29 (16.4)		
Augmentation during implantation				0.624	.732
No	825 (77)	110 (10.3)	136 (12.7)		
Yes	136 (74.7)	22 (12.1)	24 (13.2)		
Immediate implant				6.550	.038
No	846 (75.9)	126 (11.3)	143 (12.8)		
Yes	115 (83.3)	6 (4.3)	17 (12.3)		
Dentition				2.403	.301
Fully edentulous	459 (75.2)	64 (10.5)	87 (14.3)		
Partially edentulous	502 (78.1)	68 (10.6)	73 (11.4)		
Type of restoration				3.698	.157
Cemented	224 (78.9)	33 (11.6)	27 (9.5)		
Screwed	737 (76.1)	99 (10.2)	133 (13.7)		
Total	**961 (76.7)**	**132 (10.5)**	**160 (12.8)**		

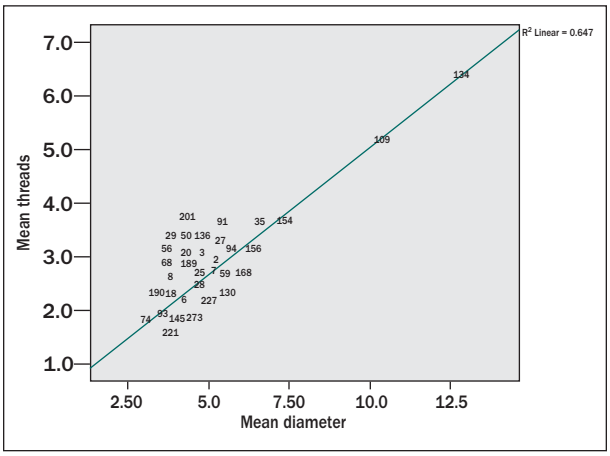

Fig 1 Plot of mean marginal bone loss and mean diameter of implants.

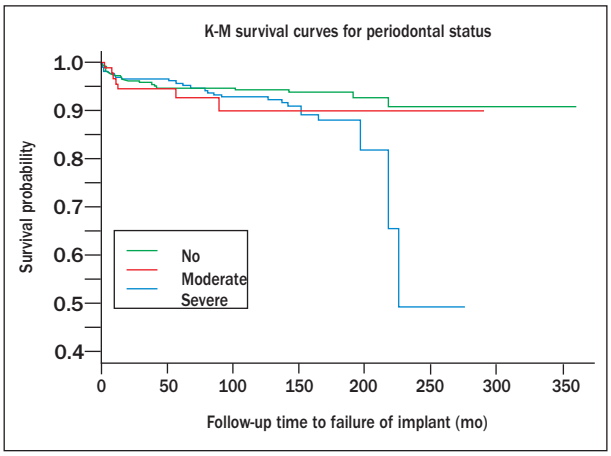

Fig 2 The relationship between periodontal status and periodontal distribution and implant survival rate.

bone augmentation was performed simultaneously also had a higher failure rate than implants without simultaneous bone augmentation. Figure 4 compares the survival time of dental implants of patients who came for scaling/root planing appointments twice a year following implant placement, with patients who did not have scaling/root planing twice a year. These study results failed to demonstrate a correlation between implant survival and patients who visited the dental hygienist twice a year.

DISCUSSION

Long-term studies utilizing a large sample size regarding the success and complications of dental implants in the geriatric population are limited. This study assessed implants in adults aged 60 years and older and found that factors such as periodontal disease and implant location impacted the success rates of implants. Implants placed in the geriatric population have been found to have predictable results.[4,5,18] However, various

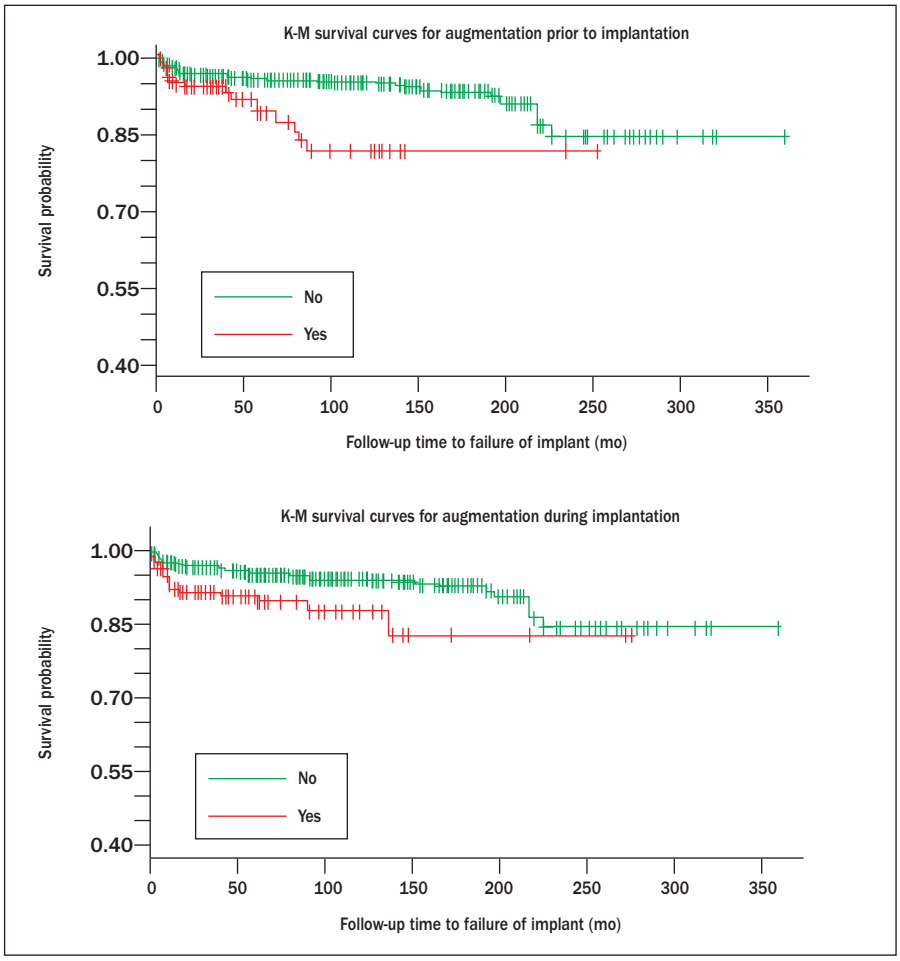

Fig 3 The relationship between implant survival rate and bone augmentation both prior to and during implantation.

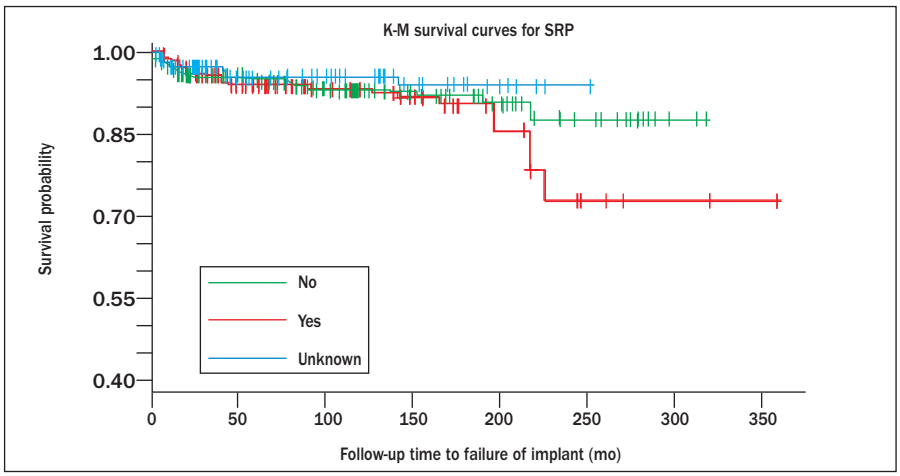

Fig 4 Illustration of implant survival in patients who came for SRP regularly, those who did not, and those who were unknown. SRP = scaling and root planing.

factors can influence the success of an implant.[20,21] The present study aimed to examine implant survival as well as indicators and risk factors for the success and failure of dental implants in adults aged 60 years and older. The current data revealed a statistically significant correlation between implant failure and sex, implant location, periodontal status distribution, and bone augmentation both prior to and during implant placement. Individuals who had bone augmentation were found to have a lower survival probability. This is congruent with the findings of Olmedo-Gaya et al, where implant failure was found to be more frequent in men, in individuals with severe periodontal disease, and in cases where bone expansion treatment was used for implant placement.[20]

Periodontal disease has been widely reported to be a risk factor for implant failure.[8,16,17] The present study found that individuals presenting with generalized periodontitis have a significantly higher hazard ratio compared with individuals with no history of periodontal disease. Levin et al had similar results and found that patients presenting with severe periodontal disease had a higher risk for implant failure.[17] A meta-analysis (of 13 studies) done by Wen et al had similar findings regarding periodontitis as a risk factor for the survival of dental implants.[16] Success of implants can also be measured by the amount of marginal bone loss surrounding an implant.[22] The present study found a higher percentage of individuals with a history of generalized periodontal disease to have severe marginal bone loss around the implant. A history of periodontal disease has also been linked to the risk of peri-implantitis.[23,24] Therefore, assessing a patient's periodontal state is crucial prior to the placement of an implant. To ensure implant success, implants should be placed in periodontally stable patients to minimize marginal bone loss and peri-implantitis.

An additional factor found to be associated with marginal bone loss around dental implants was the diameter of the implant. An increase in the implant diameter was associated with an increased amount of marginal bone loss around the dental implant. This might be due to a lesser amount of surrounding bone when using wider implants. However, according to a study done by Dalago et al, implant diameter was not found to be a risk factor for peri-implantitis[24]; further studies are required to determine the significance of implant diameter in relation to peri-implant health.

Proper preparation of the patient prior to implant placement is important for implant success. To ensure the best outcome for the patient, the patient's periodontal status should be carefully assessed, as it has been demonstrated to have a critical influence on the outcome of the implant. Once the implant has been restored, it is important to have the patient monitored closely by organizing a regular maintenance routine for professional dental hygiene care and overall re-evaluation. The results from this study failed to demonstrate a correlation between implant survival and patients who visited the dental hygienist twice a year. The patients in this dental clinic were often having their implants maintained through a combination of recall visits at the prosthodontist's office as well as visits with the general/family dentist. Therefore, the lack of correlation between implant survival and dental hygiene visits needs to be interpreted with caution due to the absence of information about the patients' maintenance visits. Further studies should address this issue comprehensively. Previous reports, however, have shown higher survival rates in patients following a frequent and consistent maintenance program.[25–27] Another possible reason for the lack of correlation may be that implant patients might require more frequent maintenance appointments and that twice a year might not be enough to have a protective role in dental implants. Further comprehensive analysis is warranted, as lifelong professional maintenance of dental implants has been found to be imperative for implant success in other studies.[25–27] Patients with dental implants should have a professional recall interval of at least 6 months.[25–28] This interval should be less if risk factors such as limited cleaning ability or other complications are involved.[25]

Although implant placement in older adults was found to be successful, factors associated with implant failure should be assessed prior to placement. Implant size, need for bone augmentation, and periodontal disease are factors associated with peri-implantitis. Peri-implantitis increases the chance for implant failure, and therefore, appropriate measures should be taken to prevent this disease.

Limitations of this study involve its retrospective nature as well as the convenience sample that was used. Additionally, the patient charts were organized for private practice, not research purposes; therefore, data were not always recorded in a consistent manner as would be the case in recording data for research purposes. This study chose a convenience sample of adults aged 60 years and older and did not compare the results to a younger sample or any other comparison group. In the future, studies with a comparison group as well as a larger sample could be conducted.

Clinical Relevance

Implants are increasingly more commonly used for restoring the dentition, and with the increase in life expectancy, older adults are entering the dental office with the intention to maintain a functioning dentition and are choosing dental implant treatment. The purpose of this study was to determine if dental implants

perform well in an older adult population. According to this study, if the contributing factors for implant failure are controlled, implant success and survival rates are comparable to previously published research on implants in the general population. Thus, implants can serve as a viable treatment option for elderly people as long as proper patient preparation and follow–up maintenance and evaluation are completed.

CONCLUSIONS

The overall findings concluded that implants can be successfully placed in an older adult population. A variety of factors are integral to the long-term success of the implant, and special consideration should be taken prior to placing implants in older adults to minimize the influence of those risk factors.

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