SCIENTIFIC ARCHIVES OF DENTAL SCIENCES (ISSN: 2642-1623)

Volume 3 Issue 2 February 2020

Research Article

Long-Term Evaluation of Dental Implants in the Elderly Population

Ibañez JC[1]*, Fuks D[2], Juaneda MA[3], Ibañez MI[3], Ibañez MC[3] and Calvo-Guirado Jose Luis[4]

[1]Director of the Career of Specialization in Oral Implantology, Faculty of Medicine of the Catholic University of Córdoba, Córdoba, Argentina

[2]Assistant Professor, Chair of Periodontics "A", Faculty of Dentistry, National University of Córdoba, Specialist in Oral Implantology, Faculty of Medicine of Catholic University, Córdoba, Argentina

[3]Assistant Professor of the Career of Specialization in Oral Implantology Faculty of Medicine of the Catholic University of Córdoba, Specialist in Oral Implantology, Faculty of Medicine of the Catholic University, Córdoba, Argentina

[4]Full Professor of Oral Surgery and Implant Dentistry, Faculty of Health Sciences, UCAM-Catholic University of San Antonio de Murcia, Murcia, Spain

***Corresponding Author:** Ibañez JC, Director of the Career of Specialization in Oral Implantology, Faculty of Medicine of the Catholic University of Córdoba, Córdoba, Argentina

Received: December 17, 2019; **Published:** January 07, 2020

Abstract

Background: To determine the long-term success and survival rate of dental implants in the elderly population.

Methods: 817 double acid-etch implants placed in 178 patients ranged from 65 to 96 years old, with a follow-up up to 15 years. Of the total implants, 530 were placed in women and 387 in men. 75% of the patients were between 65 to 74 years old while 25% were 75 years old or more. 7.71% were smokers and 47.98% were bruxers, 54.1% of the implants were placed in the maxilla and 29.9% in the upper posterior sector. 98% were an external connection, 57, 9% were tapered, 27.78% of 13 mm in length and 71.60% were 4 mm in diameter. The most common type of surgery was 2 stages (58.8%) and 75% of implants were placed deferred to the extraction. Most of the prosthesis were screw-retained.

Results: The cumulative success rate was 98.80% preload and 95.59% afterload. The survival of the implants at 15 years was lower in females ($p = 0.018$), maxilla ($p = 0.026$), upper posterior sector ($p = 0.008$), soft bone (Trisi-Rao) ($p = < 0.001$), type IV bone (Lekholm-Zarb) ($p = < 0.001$), 2-stage surgery ($p = 0.040$) and short implants ($p = < 0.001$). When applying Cox regression model, bone type ($p = < 0.001$), maxilla ($p = 0.042$) and length ($p = <0.001$) proved to be independent risk variables for implant failure.

Conclusion: Placement of double acid-etched implants in patients older than 64 years is a predictable technique.

Keywords: Elderly; Dental Implant; Survival Analysis; Osseointegration

Introduction

The geriatric population is increasing in number throughout the world, especially in developed and developing countries. In 1956 the United Nations Organization classified the population as "Young", "Mature" or "Aged" according to the percentage of people who were over 65 years old [1].

Since the middle of the last century in Latin America and the Caribbean, population aging has increased exponentially [2].

Argentina is in a process of advanced aging, being one of the oldest countries in Latin America. It has an approximate population of 4,091,944 people over 65 years of age, which represents 10.2% of the total population. It is expected that by 2050 one in five people will be over 65 [1].

It is believed that as a person increases their age, the biological and metabolic processes slow down. As a consequence, the organism would have less response capacity and would be more predisposed to suffer diseases. In fact, the elderly in general are more predisposed to chronic diseases, often poorly controlled and require chronic treatments. For this reason, for a long time, elderly patients were considered at high risk of complications with the placement of dental implants.

At the oral level, aging means total loss or partial loss of teeth that produce a decrease in masticatory capacity. Numerous scientific works talk about the difficulties generated by not having good oral health due to lack of teeth or poorly adapted prosthesis [3-10]. The placement of dental implants and then, prosthesis could restore the lost function and could improve the quality of life in different aspects: functional, aesthetic, psychological, social and systemic [3,5,6,11-14].

At present, it is discussed whether there is greater difficulty in achieving osseointegration of dental implant in these patients. For this reason, there are oral health professionals who are reluctant to use them for fear of failure. However, new studies talk about the success and safety of implant placement in this population

In a retrospective study that included 47 patients older than 79 years, who received 160 implants, 150 of them were osseointegrated. The percentage of survival of the implants was 99% in the mandible and 100% in the maxilla. The authors concluded that implant placement in geriatric patients is predictable and safe. Also, they proved to increase the quality of life of their patients [15].

In another retrospective study, 35 patients older than 70 years were studied and it was observed that after approximately 30 months after the placement of the prosthesis, the mean peri-implant resorption was 0.27 mm per year. It was also observed that the resorption was not related to the type of prosthesis, the type of surgery or the presence or absence of systemic disease. Finally, the authors concluded that implant therapy in geriatric people in whom systemic diseases were controlled could not be considered high risk [7].

A review that studied the placement of implants in geriatric patients concluded that the age of the patient should not be an exclusion factor for implant placement that implants are very valuable to give greater support and retention to the dental prosthesis and decrease the ability to achieve proper oral hygiene is not a contraindication for placement. Finally, this review recommends that all specialist dentists take into account the potential risks, possible medical complications, and psychosocial issues that could affect the prognosis of the implants [16].

Some research studies studied age as a risk factor for osseointegration failure and decreased survival of dental implants and concluded that short and medium term success was not affected by age [4,5,11,12,15]. Until now, the need for treatment with dental implants and the behavior of implants in the aging population of Argentina has not been published.

Purpose of the Study

The purpose of this study was to determine the long term success and survival rate of osseointegrated dental implants in the elderly population.

Materials and Methods

A retrospective clinical observational study of 817 double acid-etch implants (Osseotite® Implants, Biomet 3i Implant Innovations, Palm Beach Gardens, FL) placed in 178 patients aged 65 years and over, with a follow-up of 1 to 15 years was performed. All the surgical procedures were carried out in private practice and in the Career of Specialization in Oral Implantology, Catholic University of Córdoba, Argentina between 1998 and 2014. All the patients sign an informed consent form and the study was carried out in accordance with the international ethical guidelines for the research and biomedical experimentation on human beings (Declaration of Helsinki 2008), ensuring the protection and confidentiality of patient data.

In this study, patients with age equal to or greater than 65 years were included, all of them with clinical and radiographic controls, and with controlled systemic pathologies. Exclusion criteria were: implants placed in patients under 65 years of age, patients with some systemic pathology not controlled, severe chronic renal affections, uncontrolled diabetics, hyperparathyroidism, immunosuppressed, those in treatment with intravenous bisphosphonates, or with severe osteoporosis of the maxilla and patients who have received chemotherapy treatment, dental implants placed within 2 years after receiving radiation therapy in the head and neck, implants treated with another surface different than double acid etching, implants without load, or without follow-up for at least 1 year after loading. Implants with platform switching (PS) were also excluded.

Sample distribution

Data from 1050 implants were collected from 1998 to 2014, of which 233 were excluded because they did not gather the inclusion criteria. Finally, 817 implants placed in 178 patients aged 65 or older were included. All of them were Osseotite® double acid-etched implants (Biomet 3i, Palm Beach Gardens, FL, USA).

The patients were classified into two groups: Patients between 65 to 74 years old, and patients 75 or more years old. 75% of the implants were placed in patients between 65 and 74 years old. The maximum age treated was 86 years. Of the 817 implants, 530 (64.87%) were placed in women and 387 (35.13%) in men. Table 1 shows the distribution of the sample in relation to gender, age, and habits. Considering smoking patients those who smoked more than 10 cigarettes/day prior to surgery and bruxomans when they presented clinically facets of wear, grinding and/or clenching of the teeth in combination with other symptoms such as jaw pain, headache, earache, anxiety, stress, tension and/or eating disorders [17,18].

	n	%
Gender		
Female	530	64,87
Male	287	35,13
Age		
65 - 74 years	613	75,00
≥ 75 years	204	25,00
Habits		
Tobacco	63	7,71
Bruxism	392	47,98
n total: 817 implants (100%)		

Table 1*: Descriptive of patients.*

In relation to the maxilla and sector, 442 dental implants were placed in the upper jaw and 375 in the lower jaw. In addition, they were placed more frequently in the posterosuperior sector (29.9%) (Table 2).

	n	%
Sector		
Antero-inferior	143	17,50
Antero-superior	200	24,48
Postero-inferior	230	28,15
Postero-superior	244	29,87
Maxilla		
Upper	375	45,90
Lower	442	54,10
n total: 817 implants (100%)		

Table 2: *Distribution according to sector and maxilla.*

Two different connections were used: external (799 implants) and internal (18 implants) always connected matching with the abutment or prosthesis, without a switching platform. The distribution of the sample in relation to the shape, size, and length of the implants was determined according to the patient's needs and according to the operator's experience. In terms of the shape, parallel-walled implants (344 implants) and tapered ones (473 implants) were placed. According to the length, implants of 6.5 mm, 7 mm, 8.5 mm, 10 mm, 11.5 mm, 13 mm, 15 mm and 18 were placed. In relation to width, 3.25mm, 3.75mm, 4mm, 5mm, and 6 mm implants were used. The 98% of the implants presented an external connection. The shape of the most used implant was tapered (57.9%). The most common length was 13 mm (27.78%) and the most usual width was 4 mm (71.60%) (Table 3).

	n	%
Connection type		
External	799	97,80
Internal	18	2,20
Shape		
Parallel walls	344	42,11
Conical	473	57,89
Length		
6,50	7	0,86
7,00	23	2,82
8,50	83	10,16
10,00	106	12,97
11,50	148	18,12
13,00	227	27,78
15,00	211	25,83
18,00	12	1,47
Width		
3,25	5	0,61
3,75	138	16,89
4,00	585	71,60
5,00	73	8,94
6,00	16	1,96
n total: 817 implants (100%)		

Table 3: *Implant distribution according to characteristics.*

Lekholm-Zarb [19] and Trisi-Rao [20] classifications were used to classify the density of the bone at the site where each implant was placed. This density was taken by the surgeon who placed the implant according to their tactile sensation when passing the 2 mm bur. The distribution for Lekholm-Zarb classification was: type I n = 40 (4,9%), type II n = 233 (28,5%) type III n = 470 (57,5%) type IV n = 74 (9,06%) According to the Trisi-Rao classification: hard n = 40 (4,9%), normal n = 702 (85.9%) and soft n = 75 (9,18%).

Surgeries of 1 or 2 stages were carried out, as the case requires. In relation to the moment of the extraction, the placement of the implant was performed immediately after the same, in an intermediate form (25 to 60 days after the extraction) or in a deferred form (more than 60 days after having performed the extraction, placing the implant in the scarred bone). When evaluating the type of surgery, the most common were 2 stages with a frequency of 58.8%. 75% of the implants were placed in a deferred form upon extraction.

Surgical procedure

All patients took systemic antibiotics, some of them Cefixime 400 mg (Novacef, Gador, Argentina) every 24 hours for 8 days starting 24 or 48 hours before surgery depending on the case. Others, Amoxicillin, (Amoxidal, Roemmers, Argentina) starting with a dose of 2 gr of Amoxicillin 1 hour before surgery, continuing with a dose of 1 g 6 hrs after surgery and 0.5 gr every 8 hours for 4 to 5 days. Allergic patients received erythromycin 500 mg (Pantomicina, Bago, Argentina) (every 6 hours for 7 days starting 48 hours before surgery. Analgesic and anti-inflammatory (Flurbiprofen 100 mg, Clinadol Forte, Gador, Argentina) were prescribed the same day of surgery and then continued every 8 hours for two days.

Before the surgery, 0.12% chlorhexidine was dosed and then twice a day for 15 days.

Surgical procedures were performed according to the clinical and radiographic characteristics of each patient. In all the patients, a crestal or paracrestal incision was made considering keeping the greatest possible proportion of attached gingiva. Then, the bed was made for the placement of the implants following the standard protocol using a low speed (1500 rpm) and irrigation with saline solution, adapting the drilling protocol to the density of the bone. The implants were placed in the bone at very low speed (20 to 30 rpm) without irrigation. They were placed in a crestal position in the posterior sector and sub-crestal in the anterior sector on the mouth. Then, the flap was repositioned and closed with horizontal suture. All surgeries were carried out under sterile technique.

Prosthetic protocol

The choice of restoration type was made according to the clinician's criteria and the case considerations. The most frequent type of prosthesis was screwed-retained fixed restoration: n = 668 (82.78%), cemented restorations: n = 123 (15%) and bars: n = 16 (2%)

The loading time was different in the different implants. Deferred was used in 457 implants (56,6%) early in 25 (3,10%) and immediate in 325 implants (40,3%). Immediate loading was called functional when restorations of full or partial arches had occlusal contact: n = 293 (90,4%); semi-functional, to prosthetic restorations retained by bars or attachments on implants with occlusal contact: n = 9 (2,8%), and non-functional to provisional restorations without occlusal contact (immediate provisionalization): n = 23 (7,08%) [18,21-24].

Guided bone regeneration procedures (GBR)

GBR was carried out in those cases in which the operator considered it necessary, either prior to or simultaneously with the placement of the implant or implants [23,25].

On 216 implants GBR was performed and most of the time was simultaneous to the surgery (85.2%).

Follow up

The postoperative controls were performed 1 to 2 weeks after surgery, at one month, at 3 months, at 6 months and at one year after surgery up to 15 years. Subsequently, the patients were monitored annually.

The criteria to evaluate the success of the implants were:

1. Absence of infection or significant inflammation.
2. Absence of peri-implant radiolucency.
3. Absence of progressive and severe loss of bone.
4. Absence of clinical mobility.
5. Absence of pain.
6. And the absence of progressive or severe bone loss: no more than 1.5 to 2.0 mm in the first year and no more than 0.2 mm per year after the first year [26].

Radiographic evaluation

In all cases, parallel periapical radiographs were taken using an appropriate device (Super Bite, Hawe Neos Dental, Bioggio, Switzerland). In them, the height of the mesial and distal bony crest was measured to evaluate the bone level in each of the implants. The measurements were made immediately after the surgery, and then annually.

The length of the implants was used to calibrate and calculate the normality factor of each measurement of the implant. The bone level was measured taking into account the implant-bone contact in each of the radiographs. The measures were taken by 3 different operators or registering the most significant. The results were compared with the bone level at the time of insertion [17,21-23,25].

Statistical analysis

Descriptive analyses were performed for each variable and frequency tables or summary measures: mean, median, average, range and standard deviation, as applicable. The cumulative percentage of success and survival were calculated based on the number of implants followed. In order to relate the different variables to the failure of the implants, Kaplan-Meier survival tests were applied. Cox regression was used to model the risk that affects the survival of the implants. In all cases, the level of significance was fixed at 0.05.

Results

In this retrospective study, the behavior of 817 double acid-etch surface implants (Osseotite® 3i implant innovations, Palm Beach Gardens, FL) placed from 1998 to 2014 on 178 patients 65 years of age or older were analyzed. Only 36 implants failed to result in a 95.59% of success. Patients between 65 to 74 years old (n = 613) achieved a success rate of 95.09% while patients from 75 to 96 (n = 204) years old achieved a 94.6%.

Table 4 details the percentage of annual success and the cumulative success rate of both pre-load and post-load, with a cumulative success rate of 98.80% and 95.59%, respectively.

Table 5 details the modification of the bone level, showing mesial and distal bone level and the mean of bone level changes.

Years of follow-up	n of implants followed per year	n Total implants	Failures	Success percentage	Accumulated success
Prior to loading	817	817	10	98,80%	98,80%
After loading					
0-1 years	599	807	25	95,83%	95,71%
2 years	429	782	0	100%	95,71%
3 years	295	782	0	100%	95,71%
4 years	257	782	1	99,61%	95,59%
5 years	222	781	0	100%	95,59%
6 years	172	781	0	100%	95,59%
7 years	125	781	0	100%	95,59%
8 years	104	781	0	100%	95,59%
9 years	94	781	0	100%	95,59%
10 years	46	781	0	100%	95,59%
11 years	60	781	0	100%	95,59%
12 years	7	781	0	100%	95,59%
13 years	12	781	0	100%	95,59%
14 years	12	781	0	100%	95,59%
15 years	3	781	0	100%	95,59%

Table 4: *Percentage of implant survival.*

Year	n	Mesial Media (mm)	Distal Media (mm)	Media (mm)
1	599	0,71	0,72	0,72
2	429	0,98	1,03	1,01
3	295	0,92	0,92	0,92
4	257	1,1	1	1,05
5	222	1	0,97	0,99
6	172	1,21	1,14	1,17
7	125	1,04	1,01	1,01
8	104	1,1	1,14	1,13
9	94	1,33	1,37	1,35
10	46	1,59	1,57	1,58
11	60	1,46	1,53	1,49
12	7	1,23	1,59	1,43
13	12	1,55	2	1,78
14	12	1,19	1,4	1,3
15	3	1,93	1,9	1,92

Table 5: *Bone level modification.*

Implant survival

It was observed that the following variables were related in a statistically significant way with lower implant survival: female gender (p = 0.018), upper jaw (p = 0.026), posterior sector (p = 0.008), soft bone (Trisi-Rao) (p = < 0.001), type IV bone (Lekholm-Zarb) (p = < 0.001), 2-stage surgery (p = 0.040) and short implants (p = < 0.001)

No significant statistically differences were found when studying implant survival at 15 years and the following variables: age (p = 0.410), smoking habit (p = 0.620), bruxism (p = 0.433), type of connection (p = 0.366), implant shape (p = 0.808), type of load (p = 0.324), type of prosthesis (p = 0.402), implant placement in relation to extraction (0.293), guided bone regeneration (p = 0.592) and width (p = 0.908).

When applying the Cox regression model, bone type (p = < 0.001), maxilla (p = 0.042) and length (p = < 0.001) proved to be independent risk variables for implant failure. On the contrary, the type of surgery, the level of insertion of the implant and the gender of the patient were not.

A soft bone has 5.06 times higher risk of failure. The implants placed in the upper jaw have 2.44 times more risk of failure than those placed in the lower jaw (Table 6).

	P value	Hazard Ratio	95% confidence interval	
Type of surgery (2 stages)	0,087	0,437	0,169	1,128
Type of Bone (Trisi and Rao) (reference normal)				
Soft	<0,001	5,057	2,214	11,551
Hard	0,981	1,025	0,128	8,200
Maxilla (Upper)	0,042	2,442	1,033	5,775
Gender (female)	0,238	1,734	0,695	4,329
Length	<0,001	0,755	0,658	0,867

Table 6: *Cox Regression.*

Discussion

It is known that patients 65 years old or over are considered vulnerable since a large percentage presents at least one systemic disease, alteration in the normal physiology of the bone tissue and the healing processes. Despite this and as demonstrated in our work and in other similar investigations, implant placement in elderly patients is a predictable procedure with success rates close to 99% preload and 96% afterload [10,17,18,21,22,25]. Similar conclusions were observed in the systematic review and meta-analysis carried out by Sendyk., *et al.* who determined that the risk of the loss of implants in elderly patients is not significantly greater than the risk of loss in young subjects [27].

In our study, no statistically significant differences in implant survival were observed between patients aged 65 - 74 years and patients older than 75 years of age. Contrary to our results, in the work of Park., *et al.* it was observed that the older they were, the lower the chances of implant failure [8]. Chcranovic., *et al.* observed that the possibility of failure of an implant decreased by 3.3% for each year that increased the age of the patient. They attributed these results to the fact that these patients had less bruxism, less muscle mass, less muscle strength and, in many cases, a removable antagonist prosthesis, thus decreasing the risk of applying excessive occlusal forces [28].

Of the total implants, 530 were placed in female patients. This group of patients had a higher risk of failure and shorter survival of the implants at 15 years compared to the male gender (p = 0.018) in the univariate analyses. However, when performing the multivariate analysis of Cox, we observed that women did not present a higher risk of implant failure. These results are similar to the results of Chrcanovic., *et al* [28].

When analyzing the habits of the patients, we observed that the implants placed in smokers and bruxoman patients presented no more risk of failure than those who did not have these habits. Similar results were observed in the studies of Ibanez., *et al* [17,18]. On the contrary, the studies of Chrcanovic., *et al.* and Albrektsson., *et al.* They determined that bruxism was a factor of greater risk of failure. They affirm that when dental implants receive excessive occlusal forces, marginal bone loss processes could be accelerated and in some cases, fractures and consequent failure may occur [28,29].

When evaluating the bone type, our study showed that type IV or soft bone proved to be a risk factor for the failure of the implants. In addition, when considering the location of the implants, the upper jaw was associated with a higher risk of implants failure, as well as posterior superior sites. These results are consistent and coincide with the pattern of distribution of soft bone or type IV in the upper posterior sectors of the oral cavity. When performing Cox Regression, both bone type and maxilla proved to be independent risk factors for implant failure. The presence of soft bone increased the risk of failure 5.06 times and the placement of the implant in the maxilla increased the risk of failure 2.44 times. Similar results were observed in a systematic review and meta-analysis published by Chcranovic., *et al.* in the year 2017, in which the relationship between quality and quantity of bone and the failure of dental implants was studied. This study concluded that in those places where the bone was poor in quality and volume, the failure increased [30].

When studying the length of the implant, the present study observed that the longer the implant, the lower the risk of failure. The length of the implant proved to be a factor that had a statistically significant influence on the success and survival of the implants, and this proved to be an independent protection factor that increases the survival of the implant. For each millimeter longer than the implant, the risk of failure is 24.5% lower. Long implants, unlike short implants, have greater initial stability, less risk of movement at their interface and greater resistance to bending forces [28]. On the other hand, in a study published by Ibanez., *et al.* long implants had a higher percentage of success compared to short implants, although in this study this difference was not statistically significant [18].

When evaluating the type of surgery, we observed that in those implants performed with 2-stage surgeries, the implant survival at 15 years was lower. However, when performing the Cox multivariate survival study, the type of surgery did not prove to be an independent risk factor for implant failure. Likewise, in the studies of Ibanez., *et al.* and Chcranovic., *et al.* the type of surgery did not prove to influence the survival of the implant. Both authors concluded that when the clinical case, the patient and the conditions of the terrain allowed it, it is preferable to apply one stage surgery since it decreases the number of surgical procedures and consequent risks [17,31].

Conclusion

It could be concluded that the placement of double acid-etch surface implants in patients over 64 years of age is a predictable technique over time since the accumulated success rate was 95,6% over 15 years and there were no differences between the 65 to 74 years old group and the 75 to 96 years old group. Therefore, it would be a highly recommendable treatment with optimal long-term results in elderly patients.

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