

Long-term Survival Rates of Implants Supporting Overdentures

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The study aims were to evaluate survival rates of dental implants in patients wearing maxillary and mandibular overdentures in relation to age, sex, smoking, implant splinting or non-splinting, the maxilla rehabilitated, and number of implants per dental arch. This was a prospective study of patients who were completely edentulous in either mandible or maxilla or both, rehabilitated with implant-retained overdentures, with a follow-up of at least 3 years. 95 patients with 107 overdentures were supported by 360 implants were included in the study. Rehabilitations were monitored over an average of 95 ± 20.3 months (range 36–159). Implant survival in the maxilla was 91.9% and in the mandible 98.6%, representing a statistically significant difference ($P < .05$). Age, sex and implant splinting did not influence survival rates significantly. Smokers presented a lower survival rate. Implant numbers in the maxilla had a significant influence on survival, 100% for 6 but 85.7% for 4. Three mandibular implants achieved higher survival rates (100%) but with 2 (96.6%) or 4 (99%) survival was lower, although without significant difference. Long-term results suggest that 3-implant mandibular overdentures have an equivalent survival rate to 4-implant overdentures. In the maxilla, results showed that 6 implants may be the best treatment strategy. For smokers with fewer implants retaining the overdentures, there were higher numbers of implant failures.

Key Words: *overdenture, dental implants, edentulous mandible, edentulous maxilla, denture, smoking*

INTRODUCTION

The implant-retained overdenture is an effective treatment for rehabilitating edentulous patients, restoring both function and esthetics. Several studies have observed that following implant placement, patients wearing overdentures show higher levels of satisfaction than patients fitted with non-implant-supported conventional dental prosthetics,^{1–3} and that implant survival rates over 5 years approach 100%.¹ A consensus adopted by a panel of experts at a symposium at McGill University (Canada) in 2002 effectively established that the 2-implant supported overdenture should become the first choice of treatment for the edentulous mandible.⁴ In 2009, a further consensus statement (the York Consensus Statement) was released as a support and follow-up to the McGill consensus statement; the consensus conclusion was that a large body of evidence supports the proposal of a 2 implant-supported mandibular overdenture as the minimum offered to edentulous patients.⁵

Implant-retained overdentures offer dentists the opportunity to improve the quality of life and oral health of edentulous

patients.⁶ Some of the advantages that this treatment offers in comparison with conventional dentures are better stability and retention, improved function, improved esthetics and the reduction of residual resorption of the alveolar process.^{7,8} While not as elegant as fixed prostheses, overdentures have some advantages over these appliances, such as simpler construction, fewer implants required, and lower cost. Despite the relative popularity of overdentures, there have been few prospective studies based on treatments involving more than 2 implants.⁹ The lack of homogeneity among studies and relatively short follow-up periods in most studies make further studies a necessity.¹⁰

For this reason, the aim of this study was to evaluate the survival rate of implants in patients wearing implant-supported maxillary and mandibular overdentures, in order to provide additional scientific evidence for this treatment modality. The study also analyzes implant survival in relation to age, sex, smoking, whether implants are splinted, and the number of implants per dental arch.

MATERIALS AND METHODS

This was a prospective study that took place between January 1996 and June 2007 at the Oral Implant Surgery Unit of the Valencia University Medical and Dental School (Valencia, Spain). The patients taking part were totally edentulous in either or both maxillae and were treated with implant-supported overdentures.

Inclusion criteria were: patients with adequate crestal bone height and width for the placement of implants of at least 8 mm

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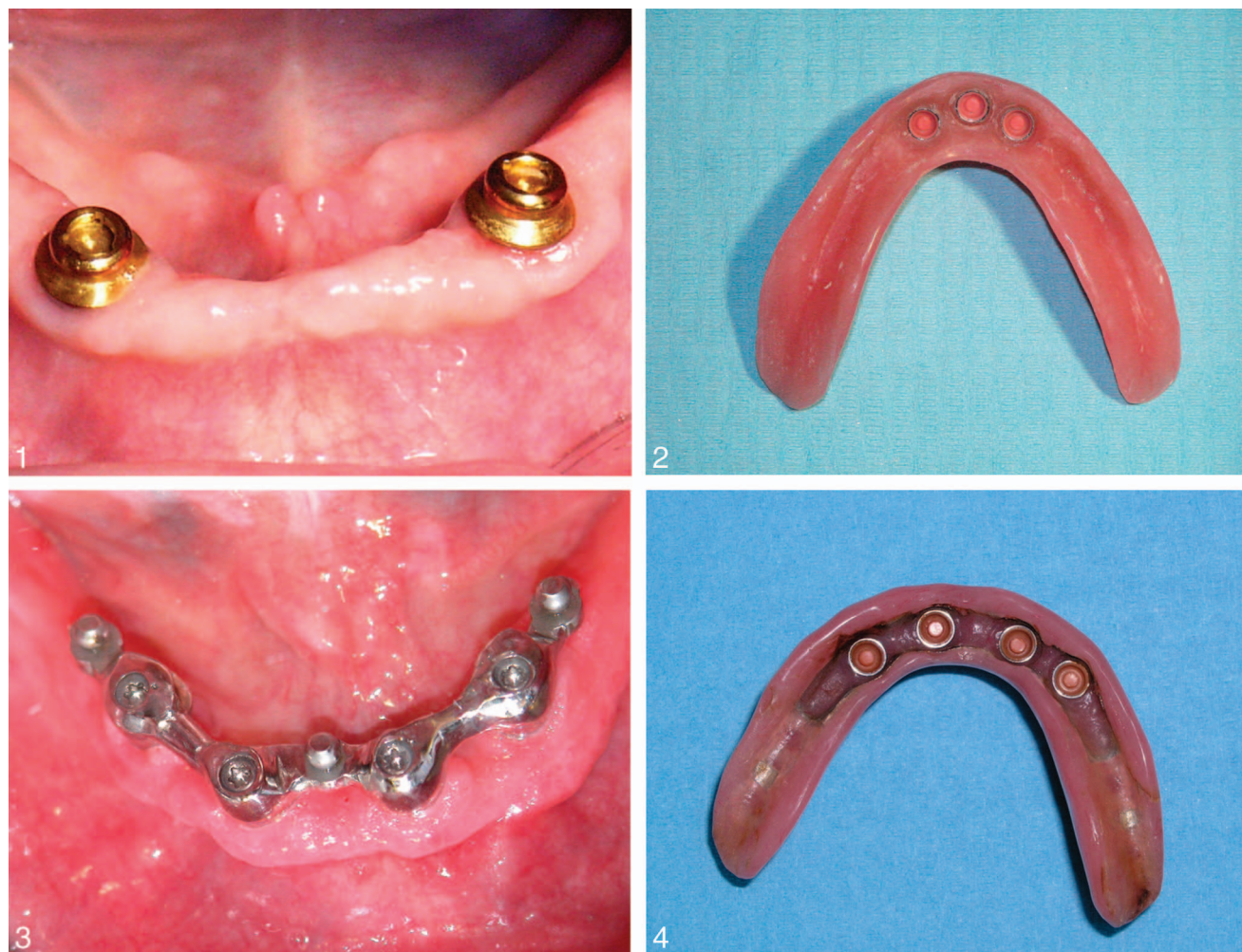
TABLE 1	
Patient clinical and demographic data	
Number of Patients (n = 95)	
Age (mean and range)	55.9 ± 9.5 years (range 23–80)
Sex (% women)	54.7
Duration of follow-up (mean and range)	95 ± 20.3 months (range 36–159)
360	
Number of implants	Maxillary 136 (37.8%) Mandibular 224 (62.2%)
Smoking	
Nonsmokers (%)	81
Smokers (%)	19
Arch rehabilitated	
Upper (%)	20
Lower (%)	67.4
Both (%)	12.6

in length in the mandible or 10 mm in length in the maxilla and 3.3 mm in diameter; patients without relevant medical antecedents; good oral hygiene, and periodontal health of teeth in the remaining antagonist arch. Those patients with a history of alcohol abuse, drug abuse, or those who had received bone grafts or who had undergone maxillary sinus lift were excluded from the study. Patients who failed to attend for a minimum 36-month follow-up or with incomplete protocols were also excluded. Table 1 provides demographic and clinical data of the patients included in the study.

Straumann Tissue Level dental implants (Institut Straumann AG, Basel, Switzerland) were placed in all patients. The participants gave their informed consent in writing prior to implant surgery. This study was exempt from institutional review board approval.

Surgical technique and prosthetic rehabilitation

Treatments were planned following standardized protocols.^{11,12} The standard procedure consisted of the placement of 4 or 6 implants in the maxilla and of 2 (Figure 1), 3 (Figure 2), or 4



FIGURES 1–4. **FIGURE 1.** Close-up image of 2 isolated Locator retainers placed in the lower canine area. **FIGURE 2.** Mandibular overdenture with three isolated Locator retainers. **FIGURE 3.** Three-section bar splinting 4 Straumann between metal foramen implants, with occlusal ball retainers. **FIGURE 4.** Mandibular overdenture with 4 isolated Locator retainers.

Mandibular overdentures on 2, 3, or 4 dental implants			
	2 Implants	3 Implants	4 Implants
Mandibular overdentures (n = 76)	30 (39.5%)	20 (26.3%)	26 (34.2%)

implants (Figures 3 and 4) in the mandible. Implants were placed in the premaxilla and for mandibular implants, in the area between the mental foramina. All surgical procedures were performed under local anesthetic using 4% articaine with 1:100 000 adrenaline Artinibsa (Inibsa, Barcelona, Spain). Total thickness flaps were elevated and all implants were placed in a single surgical session. The implants were placed by postgraduate students on the Oral Implant Surgery master's degree course under the supervision of the teaching staff.

Three months following implant surgery, the overdentures were fabricated by a single laboratory technician and placed by the same prosthodontist. The prostheses were fabricated using an intermediate abutment to support the bar (Octa, SynOcta de ITI, Straumann AG, Waldenburg, Switzerland). For overdenture retention with nonsplinted implants, isolated ball attachments (gold Dal-Ro, BIOMET 3i Implant Innovations, Warsaw, Ind) or the Locator system (Zest Anchors, Escondido, Calif) were used; prostheses on bar-splinted implants were retained by ball (OT CAP, Rhein '83, Bologna, Italy) or slide attachments (Preci-Vertix, Alphadent, Waregem, Belgium).

Implant survival rate was defined¹³ as the percentage of implants loaded and in use that did not produce symptoms such as pain, mobility or infection.

Statistical analysis

Descriptive analysis was applied to patients, implant distribution and overdenture type. Statistical analysis was performed using SPSS software 17.0 (Chicago, Ill), applying the chi-square test and Fisher's exact test. The Kaplan–Meier method was used to plot a survival curve, with a typical error of 0.075 for a 95% confidence interval. All evaluations were tested for statistical significance and $P < 0.05$ was taken as significant.

RESULTS

One hundred fifteen patients were rehabilitated with 129 overdentures. Twenty patients (63 implants, 22 overdentures) were excluded from analysis because they did not fulfill the inclusion criteria: 16 of these were excluded for lack of follow-up, 4 for not completing the questionnaires. In this way, the final study group included 95 patients rehabilitated with 107 overdentures supported by 360 dental implants.

Implants among patients who smoked showed a lower

Upper maxillary overdentures on 4 or 6 dental implants		
	4 Implants	6 Implants
Upper maxillary overdentures (n = 31)	25 (80.6%)	6 (19.4%)

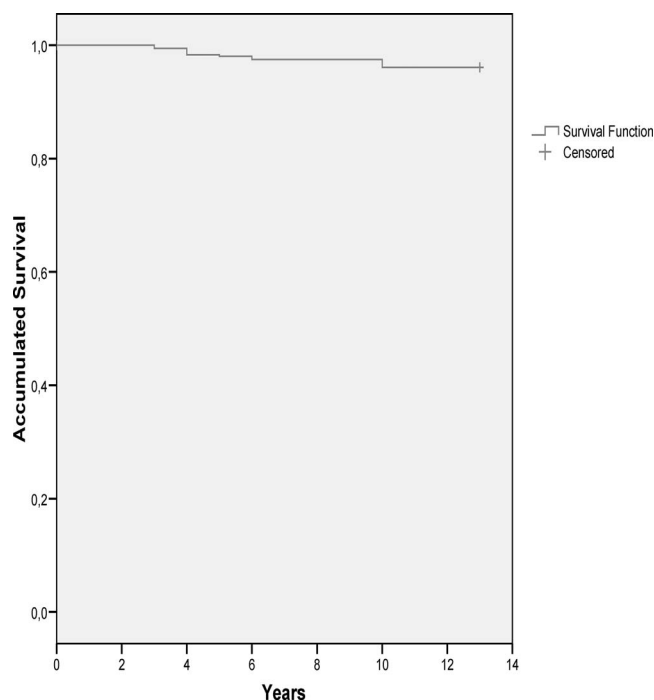


FIGURE 5. Survival curve obtained using the Kaplan–Meier method.

survival rate. Overall, 275 implants were placed in 77 nonsmoking patients with a survival rate of 97.1%, while the 85 implants placed in the 18 smokers had a survival rate of only 93%, this being a statistically significant difference ($P < 0.05$).

A total of 107 overdentures were placed (Tables 2 and 3). All maxillary overdentures (n = 31) were supported by splinted implants, while of 76 mandibular overdentures, 49 were on splinted implants and 27 on nonsplinted, a total of 80 overdentures on splinted implants (74.8%). No significant difference was found between the survival rates of splinted compared to nonsplinted implants ($P = 0.06$).

Overdentures were monitored over an average of 95 months (ranging from 36 to 159 months) with an overall survival rate of 96.1%: 91.9% in the maxilla and 98.6% in the mandible, this being a significant difference ($P < 0.05$). Over the 13-year follow-up, 14 implants failed (3.9%), 12 as a result of peri-implantitis and 2 due to implant fracture. For the failed implants, the average duration of functional loading prior to failure was 52 months. Figure 5 shows the Kaplan–Meier survival curve.

The number of implants placed in the maxilla had a significant influence on survival ($P < 0.05$), the survival rate of 6 implants being 100%, while survival on 4 implants was 85.7%. When 3 mandibular implants were placed higher survival rates of 100% were achieved, while with 2 the survival rate was 96.6% and with 4 it was 99%, although these differences were not statistically different ($P > 0.05$).

DISCUSSION

Problems arising from lack of retention and stability among mandibular prosthetics can be overcome by placing osseointegrated dental implants, used to retain an overdenture.^{1,14} This

is a widely used treatment option for 3 main reasons: to treat cases of severe bone atrophy, in order to limit economic costs and due to the difficulties of cleaning a fixed prosthesis, particularly in cases where a vestibular skirt is to be placed for esthetic or functional reasons. The literature documents survival rates ranging between 75% and 100%, over follow-up periods of between 4 and 10 years.¹ In a recent systematic review¹⁵, it was concluded that for the maxilla, there are no studies that can be utilized to address the question of how many implants should support an overdenture. For the mandible, it cannot be concluded that bone loss, patient satisfaction, or number of complications is significantly related to the number of implants supporting the overdenture.

While it is accepted that the 2-implant overdenture is not the gold standard of implant therapy it is the minimum standard that should be sufficient for most people, taking into account performance, patient satisfaction, cost, and clinical time.¹⁶ One study of 101 patients¹⁷ with a follow-up of over 10 years concluded that implant-retained overdentures are a favorable solution for edentulous patients. A literature review¹⁸ recommends the placement of at least 4 implants between the mental foramina and between 4 and 6 implants in the maxilla for the placement of overdentures supported by micromilled bars. Romeo et al,¹⁹ in a 7-year prospective study, found that survival rates of ITI implants supporting mandibular overdentures on 2 implants produced outcomes comparable to 3 or more implants. In the present study, when 3 mandibular implants were placed, higher survival rates were achieved (100%), while with 2 implants the rate was 96.6% and with 4 it was 99%; these were lower rates, although the differences were not statistically different. In a retrospective study²⁰ of 425 overdentures supported by 2 implants, a survival rate of 95.5% was achieved after 20 years loading. In another study²¹ with a 6-year follow-up of 224 implants placed in 56 patients with edentulous mandibles and rehabilitated with overdentures, the implant survival rate was 100%. In a prospective study of 59 patients with a 3-year follow-up,⁹ no significant differences were found in prosthetic survival between 3 or 4 implants, between double or triple round bars, or 2 implants and a round bar, which suggested a better cost-benefit relationship for 3 implants than 4.

Several studies^{22,23} have found survival rates of 99% in the mandible and 97.8% in the maxilla for implants supporting overdentures after a 5-year follow-up, this being a statistically significant difference ($P < 0.05$). In another study²⁴ with a 5-year follow-up, no significant differences were found between splinted and nonsplinted mandibular overdentures, a finding that is in agreement with this study. In a recent meta-analysis, there was no evidence of differences in success rates between tilted and axial implants in either the prospective or retrospective studies subject to review.²⁵

In the present study, the number of implants placed in the maxilla had a significant influence on survival, the survival rate of 6 implants being 100%, while survival on 4 implants was 85.7%. Mericske-Stern et al²⁶ found an accumulated survival rate of 94.2% at 5 years for maxillary overdentures retained by 4 implants. Zitzmann and Marinello²⁷ recommend the placement of 7 or more implants for retaining maxillary overdentures, having found a survival rate of 94.4% among 10 patients after

12 months. Slot et al,²⁸ in a systematic review of maxillary overdentures with at least 1 year of functional loading that included 3,116 implants, found a higher survival rate among 6 implants with a bar (98.2%) than with 4 implants with a bar (96.3%) or 4 isolated implants with ball attachments (95.2%), although the differences were not significant.

CONCLUSIONS

Dental implants in patients wearing overdentures had a high survival rate in the long term (mean duration of follow-up 95 ± 20.3 months). Age, sex, and splinting did not have a significant influence on implant survival. For smokers with fewer implants retaining the overdentures, there were higher numbers of implant failures. The long-term results suggest that 3-implant mandibular overdentures have an equivalent survival rate to 4-implant cases. In the maxilla, the long-term results show that 6 implants may be the best treatment strategy in terms of survival.

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