Five-Year Clinical Results of Immediately Loaded Dental Implants Using Mandibular Overdentures

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Purpose: The aim of this report is to present the clinical and patient-based outcomes of an immediate-loading protocol of TiUnite implants with mandibular overdentures in edentulous patients 5 years following initial placement. Materials and Methods: The study comprised two groups of edentulous patients. In the experimental group, 35 consecutively treated patients received 70 TiUnite implants that were loaded immediately, as well as 69 Brånemark machined implants as a backup treatment. One patient received one Brånemark implant. The control group comprised patients who were treated previously with conventional two-stage implant procedures, but were all case matched to the intervention group and served as a historical cohort. This group included 42 patients who received 111 Brånemark implants. Both groups of patients were treated with overdentures that were supported with a standardized resilient bar mechanism. Clinical and patient-based outcomes in the immediate group were recorded for the first 5 years following the initial placement of implants and were measured at various stages of treatment using two questionnaires: the Denture Satisfaction Scale and the Oral Health Impact Profile (OHIP-20). *Results:* Just over 98% of implants were found to be successful in both groups (Fisher exact test: P = 1.000). A statistically significant improvement in patients' total, mandibular, and functional satisfaction scores was found when comparing baseline data to the data obtained 5 years following loading in the experimental group (P < .001). There were no significant differences between the 1- and 5-year total, mandibular, and functional satisfaction scores, or between baseline and 5-year maxillary denture satisfaction scores. A statistically significant and positive correlation was found between baseline and 1-year maxillary satisfaction scores (P = .002). Any improvement in the patients' quality of life (QoL) was maintained during the first 5 years of loading. Conclusion: The results of this longitudinal study suggest that immediate loading of two dental implants by means of bar-retained mandibular overdentures is a predictable treatment option and leads to substantial improvement in patients' satisfaction and QoL. Importantly, this mirrors the outcomes found for patients subjected to the more commonly accepted two-stage implant procedure. Int J Prosthodont 2009;22:368-373.

Brånemark et al demonstrated that successful oral rehabilitation could be achieved reliably and reproducibly with the use of titanium tooth root endosseous implants (dental implants).¹ However, it was stated unequivocally that such success was inextricably linked to the requirement for a 3- to 6-month healing phase following placement of the implants prior to occlusal loading.²⁻⁹ Endosseous implant therapy became even more predictable and applicable to a wider spectrum of patients with the evolution of newer diagnostic modalities, modifications in dental implant geometry, and surface topography, to name a few. The evolution of new and more sophisticated and reproducible surgical approaches such as various bone grafting modalities has also led to improved treatment outcomes and broadened the scope of patients to those who might otherwise have been unsuitable for implant treatment

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in the past. Moreover, the introduction of improved restorative materials and hardware made rehabilitation of edentulous patients with dental implants more predictable.¹⁰⁻¹²

Although the 3- to 6-month period of time required prior to loading of implants has been more or less a mandatory requirement in the past,¹³ shorter surgeryto-implant healing time periods are now being advocated.¹⁴

Recent studies have compared clinical outcomes following immediate versus conventional delayed protocols and have shown similarly high levels of success.¹⁵⁻²⁶ If this is indeed the case, it might be hypothesized that immediate loading of dental implants with overdenture prostheses could be more costeffective and convenient in terms of time management and reduced financial burden for patients. In addition, the presumed reduction in morbidity associated with fewer surgical interventions implicit with early loading/single-stage implant procedures is of particular relevance to elderly patients. Despite the numerous publications regarding immediate loading, however, there is actually a dearth of sound scientific data that confirm the assumption that single-stage procedures are not only less costly than two-stage procedures, but are also equally successful. In this regard, the literature is generally limited in terms of implant survival or success-two parameters that at first glance might seem identical, but which are actually quite different from one another. Moreover, although there appears to be a large body of information regarding clinicalsuccess for various implant designs and surgical modalities, there is much less information regarding patient-based concerns in relation to treatment outcomes, including such parameters as quality of life and overall satisfaction with implant-supported prostheses.²⁷ The authors of this study have already reported on both clinical and patient-based outcomes in patients undergoing single-stage implant treatment for immediately loaded mandibular overdentures, 28,29 but longer term outcomes needed to be studied before concluding that immediately loaded endosseous implants represent a viable and predictable/reliable treatment regimen in comparison to the standard and commonly accepted two-stage implant treatment approaches.

In this article, the clinical and patient-based outcomes are reported 5 years after immediate loading of two dental implants with a bar-retained mandibular overdenture.

Materials and Methods

The study groups were selected from patients seeking treatment at the Implant Prosthodontic Unit, University

of Toronto as described in the previous report on this population of patients.²⁹ The Human Ethics Board of the University of Toronto approved both treatment protocols.

Conventional Loading Protocol

The conventional loading group (control group) was composed of 42 patients who were previously treated using the conventional two-stage treatment approach and who therefore served as the historical comparator group or cohort. Of these patients, 20.5% were active smokers and were edentulous for a mean of 13.74 ± 9.77 years. Patients in this group had at least two Brånemark dental implants (Nobel Biocare) placed, followed by a healing period of 4 months. Then, the implants were exposed and implant-supported overdentures were fabricated with a resilient ovoid bar/clip system (Cendres Métaux). A total of 111 implants were placed in this patient population (108 were loaded).

Immediate Loading Protocol

The immediate loading group (experimental group) was composed of 35 patients who were edentulous for a mean of 17.75 \pm 17.37 years. Almost 44% of these patients were active smokers. First, the patients in this group received new complete conventional dentures and were encouraged to wear them for at least 2 months prior to implant surgery. This was done to identify patients who might have confounding characteristics, including denture fabrication-related maladaptive behaviors. All patients were treated following a previously described standard protocol.²⁹ Briefly, four Nobel Biocare implants (two Brånemark and two TiUnite) were placed in the bone. The immediately loaded implants were the two TiUnite ones. Immediately after surgery, the existing dentures were hollowed out and relined with a temporary soft reline (COE-Soft Liner, GC America) that was in direct contact with the healing abutments. An ovoid bar (Cendres Métaux) was fabricated and retrofitted to the overdenture 10 days postsurgery.

For both groups, bilateral balanced occlusion was the ultimate goal when the implant-supported overdentures were fabricated.

Recall Visits

Data Collection. At the 5-year recall visit, various parameters were recorded for patients in both treatment groups. The data collected included, but were not limited to, patient demographics, general health, smoking history, and level of oral hygiene.

Criteria for implant success, as suggested in the Toronto Consensus Conference,³⁰ included testing for

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stability by torquing implants up to 20 Ncm, which allowed for the detection of pain and mobility—both criteria for failure of the implant. If such parameters were identified, the involved implants were removed.

Patient Satisfaction and Quality of Life (QoL) Outcomes. Data on these two parameters were collected for patients treated with the immediate protocol only.

Patients' satisfaction with their conventional dentures was assessed using the Denture Satisfaction Scale, as described previously elsewhere.^{28,31} Oral health-related QoL outcomes were measured using the short-form version of the Oral Health Impact Profile questionnaire (OHIP-20).32 Both questionnaires were administered at the preoperative visit (baseline) prior to the fabrication of the new mandibular conventional complete dentures as well as prior to obtaining informed consent for the study. Score magnitudes are known to correlate directly with higher levels of patient dissatisfaction or with compromised QoL. In other words, higher scores indicate less patient satisfaction and compromised QoL. In addition, patients were asked to fill out the OHIP questionnaire following the fabrication of the conventional complete dentures and after implant placement surgery and conversion of the complete denture into a bar-retained overdenture. Both questionnaires were again administered 1 and 5 years postsurgery.

The scores from the Denture Satisfaction Scale were first analyzed globally and then divided into questions relating to the individual prostheses. They were then further divided into those relating to functional status. The OHIP scores were also analyzed globally and divided into functional and psychosocial-related questions. Subscale scores were created by summing the responses to the respective questions.

Statistical Methods

The SAS statistical package was used to carry out the analyses. The Fisher exact test was used to test for significant differences in implant success (clinical and patient-based) between the two groups. To determine whether satisfaction scores changed significantly across assessment time points, a series of repeatedmeasures analysis of variance (ANOVA) was performed. To explore the relationship between patients' demographic characteristics and the 1- and 5-year satisfaction scores, a series of univariate (correlations, t tests, and ANOVAs) and multivariate correlation analyses were performed. A series of analysis of covariance was then performed to assess the effects of each of these demographic factors on the OHIP scores in a multivariate setting. Statistical significance for all the tests was set at P < .05.

Table 1 Implant Success Rates 5 Years Postloading

Group	Implants placed (lost)	Implants loaded	Success (%)*	
Conventional loading	111(2)	108	98.2	
Immediate loading	123 (2)	62	98.4	

*Fisher exact test; P = 1.000.

Results

Four patients from the experimental group failed to present for the 5-year recall visit; two had died and it was not possible to locate the other two subjects. As shown in Table 1, the percentage of successful implants at 5 years postloading was over 98% in both groups, and there were no statistically significant differences between the two groups (P = 1.000).

Denture Satisfaction Questionnaire

There was a statistically significant improvement in patients' total, mandibular, and functional satisfaction scores after both 1 year of treatment and 5 years later (Table 2). However, there were no significant differences between the 1- and 5-year total, mandibular, and functional satisfaction scores.

The differences between the 5-year and baseline maxillary denture satisfaction scores approached significance (Table 2). However, there was a significant positive correlation between baseline and 1-year maxillary satisfaction scores (P = .0025, univariate analysis). Alternatively, a negative correlation was found between the 1-year follow-up satisfaction scores and the duration of edentulism in both arches (mandible: P = .04, maxilla: P = .0265). There was no statistically significant relationship between the 5-year satisfaction scores and demographic variables when tested using either univariate or multivariate analyses.

Oral Health–Related QoL Outcomes

The mean overall OHIP and functional and psychological subscale scores dropped by 28% following the fabrication of the conventional complete dentures, and then dropped even more after implant placement surgery and conversion of the complete denture to a bar-retained overdenture. This relationship remained relatively constant after that point (Figs 1a to 1c). This indicates that the improvement in the patients' quality of life, both globally and for the functional and psychological subscales, was maintained up to 5 years following loading. No relationship was found between the various 5-year OHIP subscales and patients' demographic variables.

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	Baseline	1-y	P value*	5-y	P value* (BL vs 5-y)	P value* (1-y vs 5-y)
Maxillary satisfaction [†]	9.5 ± 5.0 (7.8, 11.3)	7.1 ± 2.8 (6.2, 8.1)	.0019	7.5 ± 4.0 (5.8, 9.1)	.0619	1.0000
Mandibular satisfaction [†]	21.0 ± 2.7 (20.1, 21.9)	6.6 ± 2.1 (5.9, 7.3)	<.0001	5.8 ± 1.9 (5.1, 6.6)	<.0001	.5671
Functional satisfaction [†]	5.5 ± 2.0 (4.8, 6.2)	2.7 ± 1.0 (2.3, 3.0)	<.0001	2.8 ± 1.2 (2.3, 3.3)	<.0001	1.0000
Total	36.1 ± 8.4 (33.2, 38.9)	16.4 ± 4.8 (14.7, 18.1)	<.0001	16.1 ± 6.5 (13.4, 18.8)	<.0001	1.0000

Table 2Mean Score \pm SDs (95% CI) on the Denture Satisfaction Scale

BL= baseline.

*Bonferroni-adjusted pairwise comparisons.

[†]Minimum rating (score) = 12; maximum rating (score) = 60.







Figs 1a to 1c Functional OHIP scores **(a)**, psychosocial OHIP scores **(b)**, and global OHIP scores **(c)**. Phases: 1 = baseline, 2 = conventional denture insertion, 3 = implant insertion, 4 = 1-year recall, 5 = 5-year recall. Functional Scores, repeated-measures ANOVA (F = 89.00, df = 4,128, P < .0001); psychosocial scores, repeated-measures ANOVA (F = 45.66, df = 4,128, P < .0001); global scores, repeated-measures ANOVA (F = 78.54, df = 4,128, P < .0001). Bonferroni-adjusted pairwise comparisons: A = 1 > 2, 3, 4, and 5 (P < .0001); B = 2 > 3, 4, and 5 (P < .0001); C = 3 and 4 (not a statistically significant difference, P = 1.000).

Discussion

There is a very large body of evidence that demonstrates that rehabilitation of the edentulous mandible with implant-supported overdentures is a feasible and predictable treatment option.^{15,16,33-36} Besides the established advantages of this treatment modality, it has been postulated that immediate loading protocols provide further advantages, particularly reductions in overall treatment time as well as decreased morbidity (ie, second-stage surgery).

The data reported here show that there is a virtually identical rate of success for implants inserted using the more conventional two-stage approach as compared to implants that are placed using a single-stage surgical procedure followed by immediate loading (just over 98%). Hence, the longitudinal findings reported here parallel findings reported by other groups.^{15–18,37}

In spite of the fact that the mandibular overdentures were supported by only two dental implants, the high success rate is probably related to several factors, including the planning and execution of treatment. In this regard, implants were all placed within the mandibular interforaminal area, which provides the most favorable bone architecture. In addition, the two dental implants were splinted early on in treatment with a passively fitted bar to insure that the amount of micromotion at the bone-implant interface was maintained well below the suggested maximum threshold.^{38,39} Duyck et al evaluated the effects of implant displacement on tissue differentiation around immediately loaded, cylindric-turned titanium implants in the tibia

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of 10 New Zealand white rabbits using bone chamber methodology.^{40,41} Bone-to-implant contact was significantly larger in the unloaded situation compared to implants subjected to 30- and 90-µm loading. This led to the conclusion that implant micromotion has a detrimental effect on bone-to-implant contact, a critically important issue in relation to the immediate loading of implants. Another important factor pertains to occlusal loading of the implant-supported prostheses such that balanced contacts are produced in both centric and eccentric mandibular positions. This approach assists in reducing the maximum applied stresses at the implant as well as the bone, which is especially important in a single-stage immediate loading situation.

Notably, the geometry of the dental implants used in this study is in the form of a screw. This configuration lends itself to the ability to transmit an axial tensile or compressive load to the surrounding bone, primarily by compression on the inclined faces of the screw. Consequently, full shear strength of the bone may develop.⁴²

Satisfaction of patients who received mandibular implant-supported overdentures was sustained up to 5 years, as evidenced by the low scores reported with the Denture Satisfaction Scale. These results are comparable to previous reports.²⁷ Alternatively, the 5-year satisfaction scores for the maxillary prostheses were higher than those at 1 year. Thus, although it is generally considered that maxillary conventional complete dentures are stable and comfortable, the differences reported here show that this is not necessarily the case over the long term. This is also consistent with the notion that implant-supported prostheses provide longer term stability and comfort than those prostheses that are not so supported. Another interesting finding was that denture satisfaction at the preoperative state of treatment for the maxillary denture was a good predictor of the degree of satisfaction reported at the 1year postoperative time point, as shown by the positive correlation between the two as calculated using univariate analyses. The negative correlation found between the 1-year follow-up satisfaction scores for both arches and the duration of edentulism suggests that patients' adaptation to the edentulous predicament improves with time, and that their treatment expectations tend to be more realistic or modest.

The improvement in QoL following rehabilitation with implant-supported overdentures was sustained at the 5-year follow-up visit. Moreover, the high levels of satisfaction were positively correlated with improved QoL according to the lower OHIP scores. This suggests that positive results on the Denture Satisfaction Questionnaire may be an indicator of an improvement in QoL, but it must be recognized that the Denture Satisfaction Questionnaire is not a direct measure of the patient's QoL (rather, it measures factors that affect QoL).

Conclusion

Within the limitations of the current clinical trial, the long-term clinical and patient-mediated outcomes of immediately loaded dental implants with a bar-retained mandibular overdenture appear to be comparable to the conventional two-stage protocol. Further research is needed to investigate the feasibility of this treatment modality using a variety of prosthetic designs and in the maxilla, where substantially lower bone density and thinner cortices are so frequently encountered.

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Oral manifestations of diabetes mellitus in complete denture wearers

This study evaluated salivary flow, salivary buffering capacity, denture retention, and oral mucosal lesions in 60 edentulous patients (30 diabetic and 30 nondiabetic). Glycemia, blood pressure, use of medications, and behavioral factors (controlled or uncontrolled diet, alcohol consumption, and smoking) reported by the subjects were also evaluated. The results were analyzed using the Student *t* test and the Mann-Whitney test for quantitative variables, and the chi-square test for qualitative variables ($\alpha = .05$). Besides the glycemia and the controlled diet by the diabetic patient, only salivary buffering capacity was found to be significantly different between the two groups. No significant differences were observed in salivary flow, denture retention, or oral lesions. Although low salivary buffering capacity doesn't have a major effect in the edentulous patient, it requires the attention of the dentist in a dentate patient with diabetes.

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