Immediate Loading of Unsplinted Implants in the Anterior Mandible for Overdentures: 3-Year Results

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Purpose: *This 3-year study evaluated the implant survival rate, peri-implant tissue response, prosthetic maintenance, and prosthetic complications in a series of patients who received two immediately loaded unsplinted threaded implants to retain a mandibular overdenture.* ***Materials and Methods:*** *Eight completely edentulous patients were evaluated clinically and radiographically immediately after implant placement, at 3 months, and at 1, 2, and 3 years after implant placement. Data were analyzed using repeated-measures one-way analysis of variance and the Wilcoxon signed rank test at a significance level of* $\alpha = .05$. ***Results:*** *At 3 years, all implants remained osseointegrated (16/16), with an overall mean marginal bone change of –0.58 ± 0.39 mm and a mean Periotest value of –7.19 ± 0.54. The modified Plaque Index scores showed marked improvement in oral hygiene during the first year, but some relapse was observed thereafter. Prosthetic maintenance and complications included replacement of the attachment inserts, abutment loosening, dislodgement of the attachment housing, overdenture reline, denture tooth fracture, and overdenture base fracture.* ***Conclusions:*** *This 3-year study suggests that, despite less than ideal oral hygiene and a high incidence of complete/partial fracture of overdentures, favorable implant survival rate and peri-implant tissue responses can be achieved in mandibular overdentures retained with two immediately loaded unsplinted threaded implants.* Int J Oral Maxillofac Implants 2011;26:1296–1302

Key words: *immediate loading, implant-retained prosthesis, mandibular overdenture, prosthetic attachments, prosthetic complications, prosthetic maintenance, unsplinted implants*

The use of two interforaminal implants to retain/support a mandibular overdenture is a cost-effective treatment option for the completely edentulous patient when it is opposed by a well-adapted and retentive maxillary denture.[1–5] Through the incorporation of dental implants, patients experience increased retention and stability of the mandibular denture, resulting in improved overall function and quality of life.[1,6–11] In 2007, Marzola et al[12] introduced the concept of immediate loading of unsplinted implants to retain a mandibular overdenture with individual prosthetic attachments. To date, only a few short-term studies have documented the viability and success of this procedure.[13,14]

The present report documents a 3-year follow-up evaluation of the implant success rate, peri-implant tissue response, prosthetic maintenance, and prosthetic complications of mandibular overdentures retained by two immediately loaded unsplinted threaded implants.

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MATERIALS AND METHODS

Patient Selection

This study was approved by the Institutional Review Board of Loma Linda University and was conducted at the Center for Prosthodontics and Implant Dentistry, Loma Linda University School of Dentistry, Loma Linda, California. This is a 3-year follow-up of a previously published 1-year case series on the immediate loading of two threaded implants (OsseoSpeed, Astra Tech) using individual prosthetic attachments (Locator, Astra Tech) for mandibular overdentures.[14] The inclusion/exclusion criteria and clinical procedures were described previously.[14]

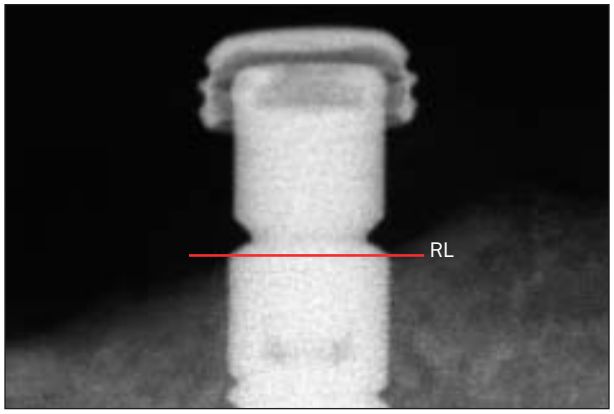

Fig 1 Reference line (RL).

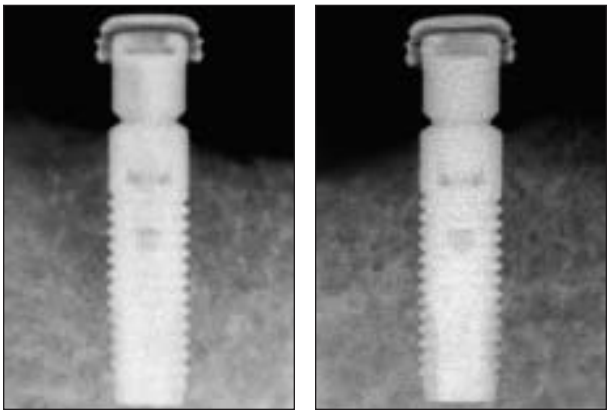

Fig 2 Standardized periapical radiographs at 3 years.

Data Collection

All patients from the original study[14] were able to return for evaluation, up to 3 years after implant surgery. One examiner performed all examinations and data collection. The evaluations were made immediately after implant placement (T0), at 3 months (T3m), and at 1 (T1y), 2 (T2y), and 3 years (T3y) after implant placement. The following variables were recorded.

- Implant survival: An implant was considered a failure if there was significant marginal bone loss, peri-implant radiolucency, mobility, pain, and/or discomfort.
- Marginal bone level change: Marginal bone levels on the mesial and distal aspects of the implants were measured using sequential periapical radiographs and the long-cone paralleling technique. The junction on the implant between the microroughened surface and the machined surface was used as a reference line (RL) (Fig 1). The distance between the RL and the implant-bone contact point was measured to the nearest 0.1 mm. The value was positive when the implant-bone contact point was coronal to the RL and negative when the implant-bone contact point was apical to the RL. Marginal bone levels were then compared between each follow-up time interval (T0, T1y, T2y, and T3y) and the changes calculated.
- Periotest values (PTV): The Periotest instrument (Siemens)[15–20] was utilized to evaluate implant stability at T0, T1y, T2y, and T3y. The implant abutment (Locator, Astra Tech) was utilized as the tapping surface for the Periotest (Siemens) instrument.
- Modified Plaque Index (mPI): The mPI[21] at the labial, mesiolabial, distolabial, lingual, mesiolingual, and distolingual surfaces of each implant abutment was recorded at T3m, T1y, T2y, and T3y. The mean mPI for each patient was calculated, and the patient's oral hygiene status was classified as good (mean mPI ≤1), fair (mean mPI > 1 and ≤ 2), or poor (mean mPI > 2).
- Prosthetic maintenance/complications: Each incidence of prosthetic maintenance and/or complication was evaluated and documented. These included repairs and/or modifications of the existing prosthesis.

Data Analysis

Repeated-measures one-way analysis of variance (ANOVA) with Sidak adjustment for pairwise comparison was used to evaluate the marginal bone changes, and the Wilcoxon signed rank test was used to evaluate PTVs. The level of significance was set at $\alpha = .05$.

RESULTS

Implant Survival

Eight completely edentulous patients (five men, three women) with a mean age of 69.1 years were included in this study. After 3 years in function, all implants (16/16) were stable and none had lost osseointegration. This corresponded to an overall implant survival rate of 100%.

Marginal Bone Level Change

The intraclass correlation coefficient for the marginal bone level measurements was 0.996, indicating that the measurement method was reliable and reproducible.[14] The overall mean marginal bone levels at T0, T1y, T2y, and T3y were 0.14 ± 0.38 mm, –0.22 ± 0.24 mm, –0.26 ± 0.21 mm, and –0.44 ± 0.39 mm, respectively (Fig 2, Table 1). Repeated measures one-way ANOVA showed significant differences in marginal bone levels between time intervals ($P = .000$; Table 1). Sidak pairwise comparisons showed that the marginal bone levels at T1y, T2y, and T3y were significantly lower than at T0 ($P < .01$, Table 1), but they were not significantly different from each other ($P > .05$; Table 1).

Table 1 Comparison of Overall Implant Marginal Bone Levels (MBL) and Overall Implant Marginal Bone Level Change (MBC) at Different Time Intervals

		MBC		
Time interval	MBL (mm)	T1y	T2y	T3y
T0	0.14 ± 0.38	−0.36 ± 0.29 (*P* = .001*)	−0.40 ± 0.26 (*P* = .000*)	−0.58 ± 0.39 (*P* = .000*)
T1y	−0.22 ± 0.24		−0.04 ± 0.13 (*P* = .804)	−0.22 ± 0.37 (*P* = .177)
T2y	−0.26 ± 0.21			−0.18 ± 0.27 (*P* = .123)
T3y	−0.44 ± 0.39			

Repeated-measures one-way ANOVA with Sidak adjustment for pairwise comparison (*statistically significant difference).

Table 2 Oral Hygiene Status Expressed as Mean mPI Scores Over Time

	Mean mPI											
	T3m			T1y			T2y			T3y		
Patient no.	G	F	P	G	F	P	G	F	P	G	F	P
1			3.0		1.3			1.0			1.6	
2			3.0		1.1			1.5			1.8	
3		2.0			1.3			1.3			1.5	
4			3.0			2.4		2.0				2.4
5			3.0		1.3				2.3		1.6	
6	0.8			0.3			0.5			0.5		
7			2.3	0.8			0.9				1.5	
8			3.0			3.0			2.5			2.5
No. of implants	1	1	6	2	4	2	2	4	2	1	5	2

G = good (mean mPI ≤ 1); F = fair (mean mPI > 1 and ≤ 2); P = poor (mean mPI > 2).

Periotest Values

The mean PTV at T0, T1y, T2y, and T3y were −5.00 ± 2.60, −6.94 ± 0.73, −7.25 ± 0.68, and −7.19 ± 0.54, respectively. There was no significant difference between PTV with respect to time ($P > .05$).

Modified Plaque Index

The mPI scores showed marked improvement in the patients' oral hygiene status during the first year, but some relapse was observed thereafter (Table 2). At T3m, the majority of patients (6/8) presented with poor oral hygiene. At T1y and T2y, two patients presented with good oral hygiene, four patients showed fair hygiene, and two patients showed poor oral hygiene. At T3y, one patient was rated as good, five as fair, and two patients as poor (Fig 3, Table 2).

Prosthetic Maintenance/Complications

Prosthetic maintenance and complications were noted throughout the study, with the most incidents between T1y and T2y. These included the replacement of nonretentive attachment inserts and dislodged attachment housings, tightening of loose abutments, repair of denture tooth/teeth, overdenture base fracture, and relining of the overdenture, which had become unstable as a result of soft tissue shrinkage (Figs 4 to 6, Table 3).

DISCUSSION

Short-term studies have shown high success rates when two unsplinted implants are immediately loaded to retain a mandibular overdenture when opposing a maxillary complete denture.[12–14] The results of this 3-year follow-up have shown that it is possible to maintain a high implant survival rate (100%) over a longer term, and this rate is comparable to implant success rates with traditional loading (83.3% to 100%)[22–26] and early loading (70.8% to 100%) protocols with more than 1 year of follow-up.[22–26]

Fig 3 Plaque accumulation around the Locator abutments. Note the stable and healthy peri-implant tissue.

Fig 4 Apparent wear of the Locator inserts.

Fig 5 Partial (stress) fracture of the denture base.

Fig 6 Complete fracture of the denture base as a result of inadequate thickness.

Studies of two unsplinted implants retaining a mandibular overdenture with more than 2 years of follow-up have reported marginal bone level changes ranging from 0 to –1.57 mm for conventional loading[22–26] and ± 0.06 to –1.61 mm for early loading.[22–26] In the present study, the mean marginal bone level change after 3 years was –0.58 mm, which is comparable to the changes reported in the aforementioned studies.[22–26] Clinical studies have shown that the typical marginal bone loss around an implant is approximately 1 to 1.5 mm during the first year of function and tends to plateau over time.[27,28] This is similar to the results of the present study, in which significant changes in the marginal bone levels were noted during the first year (T0 to T1y; $P = .001$, Table 1) but not thereafter (T1y to T2y, T1y to T3y, T2y to T3y; $P > .05$; Table 1). Nevertheless, it is important to note that the loss of marginal bone continues over time (Table 1). A longer-term follow-up is warranted to identify the time at which the peri-implant marginal bone level will become stable.

Table 3 Prosthodontic Maintenance and Complications

	Time interval		
Category	**T0 – T1y**	**T1y – T2y**	**T2y – T3y**
Per implant (n = 16)			
Wear of attachment insert	4	18	6
Dislodgement of attachment housing	–	1	–
Abutment loosening	1	–	–
Total incidence	5	19	6
Per patient (n = 8)			
Complete fracture of denture base	–	1	–
Partial fracture of denture base	–	3	–
Denture tooth fracture	–	–	1
Reline of the overdenture	1	–	2
Total incidence	1	4	3

The validity of the Periotest instrument in evaluating implant stability has been well established, and numerous authors have corroborated that the quantitative and reproducible attributes of the Periotest device make it an objective and simple method for evaluating implant stability.[15–20] In the present study, all implants consistently produced PTV between –8 and –6 at T0, T1y, T2y, and T3y. These findings indicate that all implants remained stable from the time of placement to 3 years following implant placement.

The presence of plaque can lead to inflammation of the peri-implant tissues.[11,29–32] In this study, an improvement in hygiene was noted within the first year (T3m to T1y) following implant placement. As time passed, the patients seemed less likely to sustain the same level of oral hygiene (Table 2). The patients were seen for follow-up three times during the first year after implant placement[14] but only once annually thereafter. Frequent hygiene reinforcement and motivation seemed to be a key factor in maintaining acceptable oral hygiene.

While some studies have suggested that the presence of keratinized tissue may confer strength and stability to the peri-implant tissue, making it easier to maintain and less vulnerable to inflammation,[33–35] others believe that a limited amount or the complete absence of keratinized tissue will not compromise the long-term status of implants.[36–38] In this study, the crestal incision was designed to bisect and preserve the keratinized tissue to ensure the presence of stable peri-implant tissue around the prosthetic abutment. Although most patients presented with a degree of plaque around the implant abutments throughout the study, all displayed stable and healthy peri-implant tissue (Fig 3).

Most studies reported that implant prosthetic maintenance is most common during the first year of function[11,39–45] and is related to alterations in the contour and repair of the abutment or attachments.[45] In contrast, the incidence of prosthetic maintenance in this study was highest during the second year of function (T1y to T2y; Table 3) and was primarily associated with a decrease in attachment retention, which required replacement of the attachment inserts. Apart from attachment maintenance, 38% (3/8) of the patients required a reline of their mandibular prosthesis, similar to what is expected for an implant overdenture.[45] The incidences of abutment loosening and dislodgement of abutment housing were rare and easily resolved without further consequences.

The reported incidence of fractures of mandibular implant overdenture bases has been low[42,43,46]; therefore, the need to incorporate a metal framework for reinforcement has been questioned.[47] In fact, it has been suggested that the inclusion of a metal framework may increase the bending forces on the implants, whereas a complete acrylic resin overdenture can provide the prosthesis with functional flexibility.[48] Therefore, the use of high-impact resin to minimize fractures has been advocated.[46] In this study, despite the use of high-impact resin (Lucitone 199 Denture Base Resin, DENTSPLY Trubyte), partial/complete fracture was noted in 50% (4/8) of the overdentures, which is quite high compared to other recent findings (0% to 16%).[42,43,46] All fractures were primarily located around the attachment housing and occurred during the second year of function. This can be explained by the large space occupied by the attachment housing,[49] the decrease in denture base thickness, and the fact that most of the denture base material in that area was the self-cured repair-resin used for attachment pickup procedures. In a delayed loading situation, in which the overdenture is fabricated after the final impression of the implants, the denture base can be bulked up in the appropriate area to accommodate for the attachment housing without encroaching unnecessarily into the tongue space. However, for an immediate loading situation, where the denture is fabricated prior to and the abutment housings are picked up after implant placement, it is difficult to precisely or adequately bulk up the attachment areas. Adequate or minor superfluous prosthetic space would allow for fabrication of an overdenture with proper thickness. Therefore, it is crucial that the prosthetic space be evaluated and, if needed, accommodated by preprosthetic surgery prior to definitive overdenture fabrication. In this study, all fractures were repaired, and the thickness of the denture base was increased in the area of the attachments. To ensure maximum potential strength, the overdentures were placed under pressure during the repair to ensure complete polymerization of the repair resin and to prevent the development of porosities.

Considering the mean age of the patients at the time of surgery (69.1 years), it is important to acknowledge that, while patients can learn to maintain their prosthesis and corresponding abutments, efficacy may be hindered by the physiologic changes of aging (eg, decreased coordination and eyesight). Such changes may result in an increase in prosthetic maintenance[11] and difficulty in cleaning and maintaining an implant suprastructure or abutments.[50]

CONCLUSIONS

Within the limits of this study, after a mean follow-up time of 3 years, the following conclusions can be offered.

1. The overall cumulative implant survival rate was 100%.
2. The mean marginal bone level change from 1 to 3 years was –0.22 mm, which was less than what was observed during the first year of function (–0.36 mm).
3. A marked improvement in oral hygiene was noted during the first year, but as time passed, the patients were not able to sustain the same level of oral hygiene.
4. A high rate (50%) of partial or complete fracture of the overdentures was noted.

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