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ORIGINAL ARTICLE

Dental implant-retained mandibular overdenture therapy: A clinical study of patients' response



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Abstract *Background/purpose:* The present study analyzed the subjective responses of patients to surgical placement of dental implants and the subsequent functioning of mandibular implant-retained overdentures as compared with the functioning of conventional dentures. This study sought to ascertain patient satisfaction and long-term effectiveness of tooth replacement with mandibular implant-retained overdentures.

Materials and methods: Patients ($n = 86$) unable to adapt to a conventional mandibular complete denture were treated with four one-stage titanium plasma sprayed or sandblasted, large-grit, and acid-etched threaded implants supporting an overdenture retained by a cast bar and extracoronary attachments. These patients were evaluated clinically during periods ranging from 6 months to 12 years. Eighty-three patients provided answers to queries regarding their impressions and feelings both prior to and after treatment for the implant-retained overdentures.

Results: During the study period, none of the implants or restorations failed. Ninety-eight percent of patients responding to the questionnaire were satisfied with their new overdentures. Retaining and supporting mandibular overdentures with implants yielded improvements in comfort, providing the patients with not only effective oral rehabilitation but also greater self-confidence in social situations.

Conclusion: The results indicate that mandibular arch rehabilitation by using implant-retained overdenture therapy serves as a predictable and effective treatment protocol.

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Introduction

People live longer as a result of advancements in medical science. However, as people grow older, the probability of losing some or all teeth increases. Treatment methods for providing relief to edentulous patients play an essential role in dentistry. Historical records have shown that conventional complete denture treatment improves the quality of life of edentulous patients. However, the dental ridge resorbs over time once the teeth have been lost. For a patient who has worn mandibular complete dentures for an extended period, this condition may be especially debilitating. The stability and retention of the denture prosthesis is diminished, causing discomfort, problems with facial esthetics, chewing, and biting. These difficulties can cause general dissatisfaction with the mandibular prosthesis, prompting the patient to request replacement dentures.

Such patients have typically been treated using prosthodontic surgery; for example, vestibuloplasty, a surgical procedure by which the effective height of the alveolar ridge is extended by lowering the tissue attached to the bone.^{1,2} In recent years, however, implant-retained dentures have become a standard treatment for these patients. Dental implants have been a subject of considerable research, mainly regarding design,^{3–7} biocompatibility,^{8,9} and osseointegration.^{10–12} Since the 1980s, considerable research has focused on the characteristics of implant-retained or -supported restorations, as well as the patient responses to these methods.^{13–16} In recent years, considerable research has been conducted on the application of the implant-retained overdenture in edentulous mandibles, yielding mounting evidence supporting the effectiveness of this design.

The McGill consensus statement indicated that mandibular two-implant overdentures are the first choice of care for edentulous patients.¹⁷ Numerous studies have investigated this design and provided excellent reviews of the methods, findings, and clinical concerns related to the overdenture application.^{18–23} Although no significant difference exists in the peri-implant outcome between the splinted and the unsplinted design, bar-supported overdentures have been demonstrated to require less prosthetic maintenance. Rigid anchorage of a mandibular overdenture by using a milled bar is a substantial prosthodontic advantage when compared with removable and fixed prostheses.^{24–27} Relevant literature confirms that patients prefer bar-clip attachments to ball-socket or magnet attachments.^{20–23} Therefore, the purpose of this study was to investigate clinical data and obtain the opinions of patients on the surgical treatment and subsequent functioning of implant-retained dentures. The study design was based on clinical examination and survey methodology. The results can be helpful for treatment plan and decision making.

Materials and methods

Dental health care providers at Chang-Gung Memorial Hospital, Taipei, Taiwan have noticed many completely edentulous patients suffering from severe resorption of the mandibular alveolar ridge, which affect retention of the

denture. These patients are referred to or seek the help of the denture service at the hospital, once their general practitioners are unable to satisfy their denture-related needs or expectations. Initially, a prosthodontist fits patients diagnosed with poorly fitting dentures with new conventional dentures. Treatment using an implant-retained overdenture is considered if the patient continues to experience problems, such as instability or poor retention of dentures. A prosthodontist and a periodontist collaborate to determine a treatment plan for such patients by examining the oral condition of the patients to ascertain whether mandibular implants are necessary and clinically feasible. From 1999 to 2010, a periodontist at Chang-Gung Memorial Hospital inserted a total of 344 implants into the mandibles of 86 patients (42 females and 44 males) who were edentulous for more than 2 years (i.e., four implants per patient). The mean age of the patients was 56.8 years, with age ranging between 42 years and 67 years. The duration since denture insertion ranged from 6 months to 139 months, with an average of 59 months (Table 1).

Candidate patients for a mandibular overdenture supported by an implant-retained cast bar and extracoronary attachments were clinically evaluated. Evaluation of potential mandibular implant placement sites was performed using computerized tomography with a radiographic guide. The implants used were one of the following two types: one-stage titanium plasma sprayed (TPS) or sandblasted, large-grit, acid-etched Straumann threaded implants (Straumann Institute, Waldenburg, Switzerland).^{5,6,9,28} Using local anesthesia, four implants per patient were placed at the right and left mandibular canine and first premolar regions. Implant diameters were 3.3 mm, 4.1 mm, or 4.8 mm, with lengths of 10 mm or 12 mm (Table 2). Implant placement was guided with a surgical stent.

During the first 2 weeks after surgery, the patients were asked not to wear their existing mandibular dentures. The mandibular dentures were then relined with a soft liner (GC Soft-Liner; GC Corporation, Tokyo, Japan) every 4 weeks, according to the manufacturer's instructions. Ten to 12 weeks after implant placement, a mandibular overdenture was constructed and attached to an implant-retained cast bar (58.3% silver, 25% palladium alloy, Electra; Ivoclar Vivadent, Amherst, NY, USA) 1.0 mm above the gingival tissue with two specifically fabricated, distally placed extracoronary resilient attachments (ERAs; AMP Sterngold, PA, USA; Fig. 1). Each patient also received a new conventional maxillary complete denture that involved using bilateral balanced articulation opposing the mandibular

Table 1 Follow-up time since denture insertion, 1999–2010.

Follow-up time (mo) ^a	Patients, n (%)
6–29	14 (16.3)
30–59	25 (29.1)
60–89	21 (24.4)
90–119	20 (23.3)
120–139	6 (7.0)
Total	86 (100)

^a Mean follow-up time = 59 months.

Table 2 The diameter and number of implants.

Diameter of implants (mm) ^a	Implants (n)
3.3 RN	24
4.1 RN	204
4.8 RN	108
4.8 WN	8
Total	344

RN = regular neck; WN = wide neck.

overdenture (Fig. 2). One prosthodontist constructed all of the dentures. Clinical evaluations were performed at delivery (baseline) and every 3 months thereafter by both the prosthodontist and periodontist.

At each follow-up appointment, the cast bar retainer was removed and cleaned using appropriate instruments (e.g., interproximal brush) if necessary. Pocket depths around the implants were measured, and proper oral hygiene was evaluated and reinforced. Osseointegration of the implants was clinically evaluated using several methods: mechanical mobility with the Ostell ISQ system (Flexident AG, Gothenburg, Sweden), presence of bone loss or peri-implant radiolucency, and percussion of the implants by using the blunt handle of a dental mirror. Changes to the bone around the implants were evaluated using peri-apical and panoramic films every 6 months, 12 months, 18 months, and 24 months.^{29,30}

To evaluate the subjective experiences of each patient, a questionnaire with precoded answers addressing five categories was used. The five categories were as follows: (1) experience with previous dentures; (2) experience with surgical procedures; (3) opinions related to oral hygiene; (4) opinions regarding the new dentures; and (5) opinions regarding his or her social life.

The patients completed the questionnaires anonymously 3 months after the treatment was complete. "Yes" (favorable) or "No" (unfavorable) questions for each set of dentures were included. Questions comparing patient experience with the new implant supported overdenture and with previous conventional denture types were answered independently.

Paired responses between conventional and implant-retained dentures were analyzed for each question by conducting McNemar's test with Yate's correction for continuity.³¹ The null hypothesis was applied to patients who



Figure 1 A customized cast bar with two distal extracoronal resilient attachments (ERAs) retains the mandibular overdenture.



Figure 2 A new conventional maxillary complete denture and a mandibular implant-retained complete overdenture.

experienced no subjective differences between mandibular implant overdentures and conventional dentures. In statistical testing, two-sided $P \leq 0.05$ were considered statistically significant.

Results

Eighty-three patients returned the questionnaires regarding their experiences with both conventional and implant-retained dentures. Only one patient reported that the implant placement procedure had been painful, and 47% of the patients had expected more discomfort following the procedure than they experienced. At the time of follow-up, 85% of patients had felt no pain at the implant site, although the other 15% experienced some pain (Table 3).

None of the 344 implants placed from 1999 to 2010 failed, and all were osseointegrated successfully, yielding an implant survival rate of 100% after treatment. In addition, the survival rate of the overdenture prostheses was 100%.

During the first 2 weeks after surgery, the patients were asked not to wear their existing mandibular dentures. Although 66% of the respondents did not find this restriction problematic, 34% of the respondents (all of whom were female) did not favor this part of the treatment.

Peri-apical and panoramic radiographs obtained after 6 months, 12 months, 18 months, and 24 months of implant surgery demonstrated no significant changes in bone levels around the implants. During the follow-up period, three dentures required replacement of the ERA patrilx

Table 3 Responses to questions about the implant surgical procedure.

Question	Yes (%)	No (%)
Was the procedure of implant surgery painful?	3	97
Did you actually feel more discomfort after the procedure than you expected?	47	53
During the time of follow-up after surgery, did you feel pain?	15	85

Table 4 Percentage and frequency of positive responses to questions about oral hygiene.

Question	Previous dentures (n = 83)	New dentures (n = 83)	P ^a
Do you clean your dentures more than once a day? ^a	63 (52)	96 (80)	<0.0001
Do you clean your dentures with a special brush, soap, and water? ^a	72 (60)	93 (77)	0.0015
Do you clean your implants with			
• a toothbrush?	—	85 (71)	—
• dental floss?	—	81 (67)	—
• an interproximal brush?	—	78 (65)	—

Data are % (n).

^a McNemar's test.

component because of loss of retention. Pocket depth measurements ranged between 1 mm and 3 mm, although two patients experienced gingival hyperplasia leading to the formation of pseudopockets 48 months after the bars and overdentures were inserted. When the gingiva had proliferated against the bar or the sulcus could not be kept clean, a gingivectomy was performed.

Table 4 lists the answers to the questions concerning oral hygiene. Most of the patients reported using a toothbrush, dental floss, and an interdental brush for implant hygiene. The patients reported difficulty cleaning the bar and implants, despite no question in the questionnaire addressing this concern.

Table 5 lists the percentages of the responses concerning the functioning of the new dentures as compared with the

old dentures. The results indicate that dental comfort had improved subsequent to implant therapy. The most significant results of the treatment were that pain had decreased under the mandibular overdenture and that denture stability during any excursive movements had improved.

Table 6 lists the answers to the questions regarding social interactions of the patients. Regarding visiting friends and family, a significant number of respondents appeared to let their dentures influence their choices, and the implant-retained overdenture treatment was generally regarded as enhancing social satisfaction.

Discussion

During the follow-up period, no implants exhibited gross mobility [implant stability quotient (ISQ) <40],³² horizontal bone loss greater than 1 mm, pain, infection, or peri-implant radiolucency. The implant survival rate of 100% (an average term of 59 months after insertion) is comparable with results that have been reported by other researchers using the TPS system.^{5,28}

According to the results of this study, it may be concluded that the expectations and levels of satisfaction of patients are not necessarily the same. Previous research has confirmed that expectations are affected by several factors. Patients with higher social status may be more demanding, expecting satisfaction in every aspect.³³ Younger patients tend to pay more attention to quality-of-life issues; thus, their expectations are higher. By contrast, elderly patients may have lower expectations about treatment outcome, because their disability may be more severe.³⁴ Some patients are afraid of being in pain or visiting doctors. Decisions about treatment plans may differ among patients, reflecting the personal preferences of patients.³⁵ Patients who cannot afford dental implant treatment might prefer traditional treatment because dental implant treatment is more expensive. Occasionally,

Table 5 Comparison of the denture function with and without implants retained.

Question		Previous denture (n = 83)	New denture (n = 83)	P ^a
Do you always wear your mandibular denture during the day? ^a		75 (62)	100 (83)	0.0044
Do you wear your mandibular denture while sleeping? ^a		32 (27)	38 (32)	1.0
Do you hardly ever feel pain under your denture? ^a	Maxillary	71 (59)	91 (76)	0.0133
	Mandibular	11 (9)	87 (72)	<0.0001
Does your denture stay in place during function? ^a	Maxillary	73 (61)	95 (77)	0.0077
	Mandibular	9 (7)	96 (79)	<0.0001
Can you eat well with your dentures? ^a		12 (10)	97 (81)	<0.0001
Do you ever use an adhesive to keep your denture in place? ^a	Maxillary	16 (13)	1 (1)	0.0200
	Mandibular	29 (24)	1 (1)	0.0009
Does your denture have a precise fit? ^a		63 (55)	98 (81)	<0.0001
Do your maxillary and mandibular dentures fit well together? ^a		62 (51)	98 (81)	<0.0001
Are you satisfied with your dentures? ^a	Maxillary	71 (59)	95 (79)	0.0015
	Mandibular	4 (3)	98 (81)	<0.0001

Data are % (n).

^a McNemar's test.

Table 6 Comparison of social satisfaction of the mandibular denture with and without implants retained.

Question	Previous denture (n = 83)	New denture (n = 83)	P ^a
Can you speak easily with your dentures? ^{2a}	28 (23)	94 (78)	<0.0001
Can people understand you when you speak to them? ^{2a}	41 (34)	96 (80)	<0.0001
Can you appreciate your facial appearance with your dentures in place? ^{2a}	63 (52)	97 (81)	<0.0001
Do you visit your family with your dentures? ^a	74 (61)	98 (81)	0.0120
Do you visit your friends and go to parties with your dentures? ^a	53 (44)	98 (81)	<0.0001
Do you laugh fully with your dentures? ^a	26 (21)	95 (79)	<0.0001

Data are % (n).

^a McNemar's test.

the physical condition of a patient or an illness might contraindicate treatments that are popular among higher education levels in developed countries.³⁶ Understanding the benefits and limitations of dental implants may contribute to improved satisfaction levels.³⁷ Finally, treatment quality may depend on the technical and diagnostic ability of the dentist, and a well-trained, experienced dentist is more likely to secure improved patient satisfaction.³⁸

In the present study, the overall level of satisfaction with the retention and stability of the mandibular overdenture was high. This result may be attributed to the overdenture being retained to the cast bar by using ERAs. The high percentage of patients who reported seldom feeling pain under their mandibular overdentures (87%; Table 5) can be attributed to the bar and attachments physically preventing the overdenture from moving towards the tissue, thus providing relief and protection to the alveolar mucosa of the mandible.^{10,39–43} As a result of the high comfort levels, seven patients asked for a similar prosthesis for the maxilla, even though they had not experienced any problems with their maxillary dentures.

The selection of individuals treated in this study was primarily based on their persistent dissatisfaction with conventional mandibular dentures. If the same study were to examine patients who are well adapted to wearing conventional dentures, the results may be very different.^{44,45} Nevertheless, the level of rehabilitation, regarding functional and social improvements, is impressive. The data indicate that a problematic prosthesis can lead to social isolation of the patient. In the study group, the implant enhanced the comfort and stability of their dentures. By providing a stable and comfortable prosthesis, patients have benefited from oral rehabilitation, and they have enjoyed greater levels of self-confidence and social interaction.^{46,47}

Based on this study, proper treatment apparently forms a bridge between the dentist and the patient. A good dentist must consider the condition and expectations of the patient. From the perspective of the clinician, the survival of the dental implants, the serviceability of the prosthesis, and the decreased number of complications are of utmost importance.³⁷ Patients seek to benefit from treatment, at a cost that makes it worthwhile. Moreover, the psychological impact and effect of edentulism on the social lives of patients cannot be underestimated.²⁰ Therefore, dentists should evaluate patients for denture usage, comfort level,

appearance, oral sensation, speaking ability, and confidence.⁴⁸ Although patients treated with implant-retained mandibular overdentures require more attention and aftercare than do patients treated using conventional complete dentures, the significantly higher patient satisfaction obtained using the overdenture should be considered when deciding between the two treatments.⁴⁹

Mucosal enlargement as a minor complication had sometimes been seen with implant overdenture treatment. Researchers seem to have investigated mucosal enlargement developing as a result of poor oral hygiene and plaque accumulation leading to inflammation and tissue irritation with resulting changes in the peri-implant mucosal over time.^{50,51} In addition, a good peripheral seal results in the development of a negative pressure gradient in the dead space underneath the bar of implant overdentures. This encourages localized inflamed mucosa enlargement into the dead space.⁵¹ Diversity of therapeutic preventive measure ranges from optimal plaque control⁵² and close monitoring without intervention⁵³ to surgical excision.^{50,54} Therapeutic remedies will depend on whether the clinician believes that mucosal enlargement originated from plaque etiology or from a closed environment with negative pressure. Patients in the present study were informed to keep optimal oral hygiene with an interdental brush, dental floss, and regular dental check-ups. Two patients with mucosa enlargement around implants had gingivectomy surgery by the periodontist to facilitate better oral hygiene.

One negative consequence of implant-retained mandibular overdenture treatment is that patients are not allowed to wear their mandibular denture for the first 2 weeks after implant surgery. This treatment strategy is based on the observation that a period of minimal occlusal loading is necessary for optimal osseointegration.⁹ Thirty-four percent of the respondents, all females, did not like following their daily routines without teeth. However, they agreed that the regulation was necessary once they experienced greater comfort with their new dentures.

Regarding limitations, using pocket measurements to verify implant success is questionable because their accuracy is debatable. The probe can, for example, make contact with an implant thread. No precise depth reference exists, given the lack of a periodontal ligament.⁵⁵ Furthermore, penetrating the epithelial attachment constitutes an additional risk.⁵⁶ In considering these limitations, pocket status measurements can only provide a general impression of the peri-implant status. The use of

dynamic methods to perform objective analysis of osseointegration is not universally accepted, although evidence continues to mount in favor of these methods.^{57,58}

Retaining and supporting the mandibular denture by using endosseous dental implants yielded improvements in comfort and stability, affording the patients not only effective oral rehabilitation but also greater self-confidence. These results indicate that rehabilitation of the totally edentulous mandible accomplished by using implant-retained overdenture therapy serves as a predictably effective treatment protocol.

Conflicts of interest

The authors have no conflicts of interest relevant to this article.

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