

Two-Year Success Rate of Implant-Retained Mandibular Overdentures by Novice General Dentistry Residents

Hans Malmstrom, DDS^{1*}

Jin Xiao, DDS, MS, PhD¹

Georgios Romanos, DDS, PhD^{1,2}

Yan-Fang Ren, DDS, PhD, MPH¹

The purpose of the present study was to evaluate the clinical success and patient satisfaction when dental implant-retained mandibular overdentures are placed and restored by novice general dentistry residents. A total of 50 subjects who were dissatisfied with their mandibular complete dentures were enrolled in the study. Two dental implants were placed in the anterior mandible between the mental foramina by novice general dentistry residents under the direct supervision of the principal investigator. The resident attached the denture to the implants 3 to 4 months later using locator attachments. The implant success rate was determined by measuring bone loss, mobility, pocket probing depth, and gingival and plaque indices. Subjects were asked to complete a satisfaction questionnaire with the prosthesis at 3 months, 1 year, and 2 years after overdenture delivery. A total of 100 implants were placed in the 50 study subjects. Of these, 2 implants were lost in 1 subject, and 1 subject died due to unrelated causes. Of the 48 remaining subjects, 45 have had their implants restored with overdentures. The subjects' overall satisfaction with fit and ability to chew hard foods with their mandibular overdentures improved significantly ($P < .05$) following the denture attachment to the dental implants. We conclude that novice general dentistry residents can successfully place mandibular implants and restore them with overdentures under direct supervision, subsequently enhancing the subjects' satisfaction with their mandibular dentures.

Key Words: dental implant, overdenture, treatment outcome, patient satisfaction

INTRODUCTION

There is overwhelming evidence that implant-retained mandibular overdentures (IRMOD) provide better chewing ability, stability, and retention; greater patient satisfaction; and improved quality of life than mandibular conventional dentures.^{1–5} Reports on economic evaluations of IRMOD have also demonstrated the long-term cost-effectiveness of implant overdentures compared with conventional dentures.^{6,7}

The relative merits of IRMOD vs conventional dentures for edentulous patients were discussed in a consensus conference in 2002 at McGill University in Montreal, Canada. Relying heavily on randomized controlled trials comparing IRMOD to conventional dentures, the group issued a brief consensus statement declaring the 2-implant IRMOD the “first choice” for edentulous patients, despite the higher cost.⁸ The consensus statement from the McGill group was reviewed and supported at the annual conference of the British Society for the Study of Prosthetic Dentistry in 2009.⁹ More recently, a research panel evaluated the performances of mandibular dentures in relation to 10 parameters—retention, stability, esthetics, speech, masticatory efficiency, comfort while eating soft and hard foods, confidence

in intimate situations, satisfaction, and self-esteem—and concluded that an IRMOD instead of a conventional denture should be the first choice for mandibular edentulous patients who are otherwise healthy or have mild systemic disease.¹⁰ The same panel also stated, “On the basis of results of our study, we also suggest that education regarding the IRMOD should be offered by dental schools to students, as well as in continuing education course and professional development programs.”¹⁰

Conversely, until 2006, the implant overdenture prostheses tested in clinical studies were fabricated only by skilled prosthodontists. Esfandiari et al¹¹ attempted to answer the question, “Can general dentists produce successful implant overdentures with minimal training?” through a clinical study in 2006 and concluded that no differences in scores for either prosthesis between the groups treated by experienced specialists or new dentists. The results of this randomized controlled clinical trial suggest that general dentists can provide successful IRMOD with minimal training. Aragon et al¹² conducted another study in Canada and concluded that the performance of dental students when fabricating a 2-implant overdenture is not different from that of a traditional complete denture. Students can successfully fabricate a 2-implant overdenture as perceived by both patients and prosthodontists.

However, we still do not have much information with regard to the success rate and patient satisfaction when both the surgical and restorative phases of implant therapies were performed by novice general dentists. The objective of the present study was to evaluate the clinical success and patient satisfaction when dental implant-supported mandibular over-

¹ University of Rochester, Eastman Institute for Oral Health, Rochester, NY.

² School of Dental Medicine, State University of New York at Stony Brook, Stony Brook, NY.

* Corresponding author, e-mail: Hans_Malmstrom@URMC.Rochester.edu

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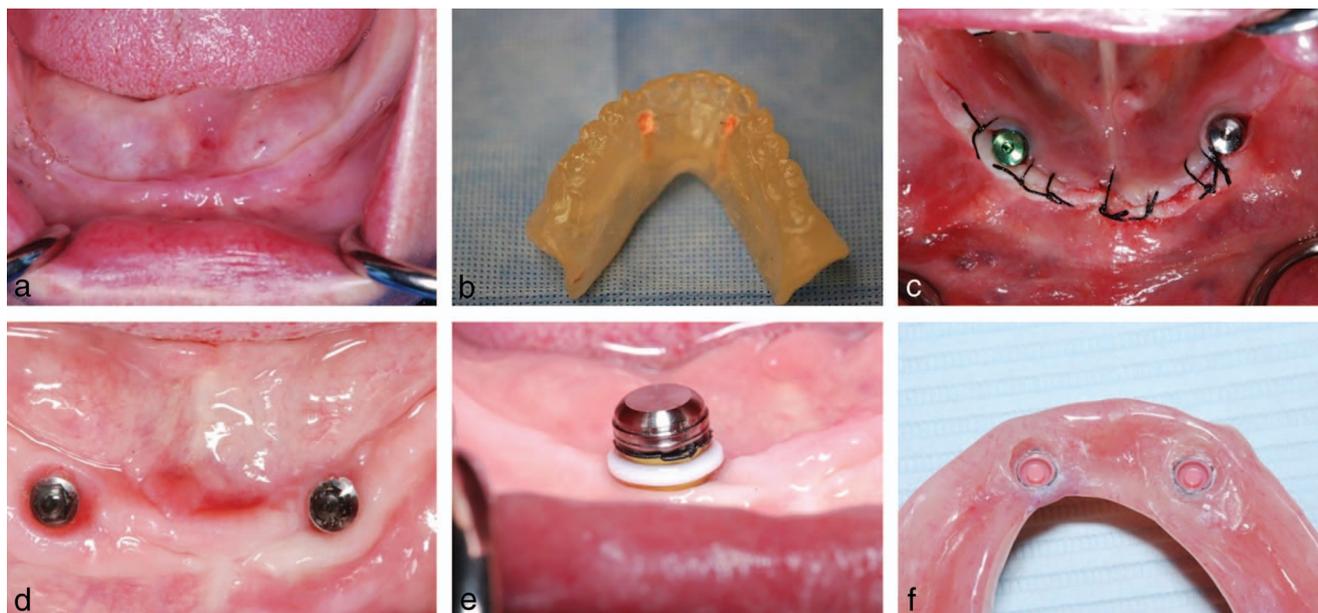


FIGURE 1. Implant-supported overdenture procedure. (a) Edentulous mandible. (b) Surgical guide. (c) Two Zimmer implants (diameter = 3.7 mm; height = 10–13 mm) were placed in the intraforaminal area. (d) Healing abutment was removed at the #22 site. (e) Zimmer locator abutment (platform diameter = 3.5mm; cuff length = 0–3 mm) was placed. Pick-up procedure is shown. (f) Denture tissue side after pick-up procedure.

dentures were placed and restored by novice Advanced Education in General Dentistry (AEGD) residents.

MATERIALS AND METHODS

Study design

Study subjects were selected from patients who recently received mandibular complete dentures about 3 months after extractions of remaining teeth. A total of 50 subjects (18 years of age or older), who were dissatisfied with their new mandibular complete dentures, were enrolled in the study. At baseline, all subjects were asked to evaluate their prosthesis for denture retention, comfort, speech, and overall satisfaction and other health-related quality-of-life issues using a visual analog scale.^{3,12–14} If not satisfied, the denture was relined and the subjects were reevaluated 6 weeks later. If satisfaction was still not achieved, 2 dental implants were placed in the anterior mandible between the mental foramina by AEGD residents with no clinical experience in placing/restoring dental implants under direct supervision. Overdentures were restored with the 2 implants 3 to 4 months after implant placement. To determine success, bone loss, mobility, gingival index, pocket depth, and plaque index were measured and subjects were asked to complete a questionnaire regarding satisfaction with the prosthesis at the 2-week, 3-month, 1-year, and 2-year follow-up visits.

Patient selection

Inclusion Criteria

Each subject was evaluated by a general dentistry resident and a faculty member to ensure they met the criteria of the study;

patients who met the following inclusion criteria were included in the study: (1) 18 years and older, (2) dissatisfied with current mandibular complete dentures, (3) able to understand and respond to questionnaires used in the study, (4) willing and able to accept the protocol and provide the consent form, and (5) medically in general good health.

Exclusion Criteria

Patients who met the following exclusion criteria were excluded from the study: (1) insufficient bone to place 2 implants between the mental foramina of the mandible, (2) severely immune compromised individuals, (3) pregnancy, (4) psychological or psychiatric conditions that could influence the treatment.

Treatment procedures performed by novice AEGD residents

Novice AEGD residents who met the following criteria were selected: (1) first-year residents from an American Dental Association–accredited AEGD program, (2) no previous experience in dental implant placement and restoration, (3) participating residents agreed to limit their clinical experience to place and restore dental implants to the study only until completed, (4) able to understand and respond to questionnaires used in the study, and (5) willing and able to accept the protocol and provide a consent form.

All surgeries were performed by AEGD residents under the direct supervision of faculty general dentists. A total of 15 residents performed the surgeries, with each resident completing 2 to 6 cases. All surgeries were performed under local anesthesia (2% lidocaine or 4% septocaine) using a surgical guide fabricated on study casts with the duplication of the mandibular complete denture (Figure 1). Prophylactic antibiot-

ics (amoxicillin 2 g or clindamycin 600 mg, 1 hour before the surgery) and postsurgical antibiotics (amoxicillin 500 mg 3 times a day for 7 days or clindamycin 300 mg 4 times a day for 7 days) were prescribed to all patients. In all cases, a full-thickness flap was raised and 2 Zimmer Tapered Screw-Vent implants (Zimmer Dental Inc, Carlsbad, Calif; 3.75 mm in diameter, 11 mm or 13 mm in length) were placed at intraforaminal area at either the canine or lateral incisor location. All implants were placed in a crestal position, and healing abutments were placed on top of the implants. Immediately following implant placement, panoramic and periapical radiographs were taken. Patients were instructed to use 0.12% chlorhexidine mouth rinse from the day after surgery for 2 weeks, and they were educated to properly clean the implant abutments. Sutures were removed at the 2-week follow-up appointment. The locator abutment (Zimmer Dental Inc; Tapered Screw-Vent 3.5 mm, 0- to 3-mm cuff) was placed on top of the implants 3 to 4 months after implant placement, and the attachment was picked up in the overdenture. The median force (pink) locator male was chosen at the overdenture delivery appointment. Patients were instructed to place and remove the overdenture properly as well as to maintain the proper hygiene of the implants and overdenture. All restorative procedures were completed by the AEGD residents under the direct supervision of faculty general dentists.

Clinical measurement

To determine the implant success, the following clinical measurements were recorded at the 2-week, 3-month, 1-year, and 2-year follow-up visits: (1) gingival index by Löe and Silness,^{15,16} (2) plaque index,¹⁷ (3) pocket depths measured using the Williams periodontal probe at 6 sites (mesiobuccal, midbuccal, distobuccal, mesiopalatal, midpalatal, and distopalatal), (4) mobility measured manually and recorded as yes (1) or no (0), and (5) bone loss as measured from radiographs. Measurement and evaluation were done by an experienced and calibrated clinician who was not the one placing the implants. Intraexaminer calibration was done prior to the measurement, and the Kappa score was 0.85.

Implant success, as a combination of the success criteria previously defined by Albrektsson et al¹⁸ and adapted by Buser et al^{19,20} as well as Karoussis et al,²¹ was considered. It included absence of mobility,¹⁹ absence of persistent subjective complaints (pain, foreign body sensation, and/or dysesthesia),¹⁹ absence of recurrent peri-implant infection with suppuration,¹⁹ absence of a continuous radiolucency around the implant,¹⁹ no pocket probing depth (PPD) >5 mm,^{22,23} and no PPD \geq 5 mm and bleeding on probing.²² During the first year, 1.5 mm of vertical bone resorption was accepted. After the first year of insertion, the annual vertical bone loss should not exceed 0.2 mm (mesially or distally).^{18,24}

Radiographic measurement

Panoramic X rays were taken for each subject for radiographic evaluation at 2 weeks, 3 month, 1 year, and 2 years, respectively, and the radiographs were loaded in imaging software Dolphin 3D imaging 11.5 (Patterson Dental Supply Inc, St Paul, Minn). A 2-stage process was accomplished: (1)

digitization of the films and adjustment of the images for optimum contrast and density and (2) calibration of the magnification/distortion in each image according to the length from the top of the abutment locator to the apical tip of the implant using implant planer module in the software. The distance from the top of the abutment to the mesial and distal crest bone levels was measured after calibration (Figure 2). Bone loss was calculated for 4 points: #22 mesial and distal and #27 mesial and distal locations.²⁵

Overdenture prosthesis evaluation

The overdenture prosthesis was evaluated by an experienced and calibrated clinician who did not place the implants and restore the overdenture prosthesis. Overdenture stability, retention, and esthetics were assessed based on a scale of 0 (poor) to 10 (excellent) at the 2-week, 3-month, 12-month, and 24-month follow-up visits, respectively. Patient maintenance appointment information was collected to summarize the prosthesis complications including the need for denture relines, locator male replacement, loosening of the locator abutment, and denture fracture.

Patient satisfaction evaluation

At the 2-week, 3-month, 12-months, and 24-month follow-up visits, a patient satisfaction evaluation of the overdenture prosthesis was performed regarding restoration comfort, esthetics, chewing function, speech, and general satisfaction. The rating of each category was based on a visual analog scale of 100 mm that used key words such as *extremely difficult* or *not at all satisfied* at 0 mm and *not at all difficult* or *extremely satisfied* at 100 mm. The higher the score, the better the prosthesis as perceived by the patient.

Statistical analysis

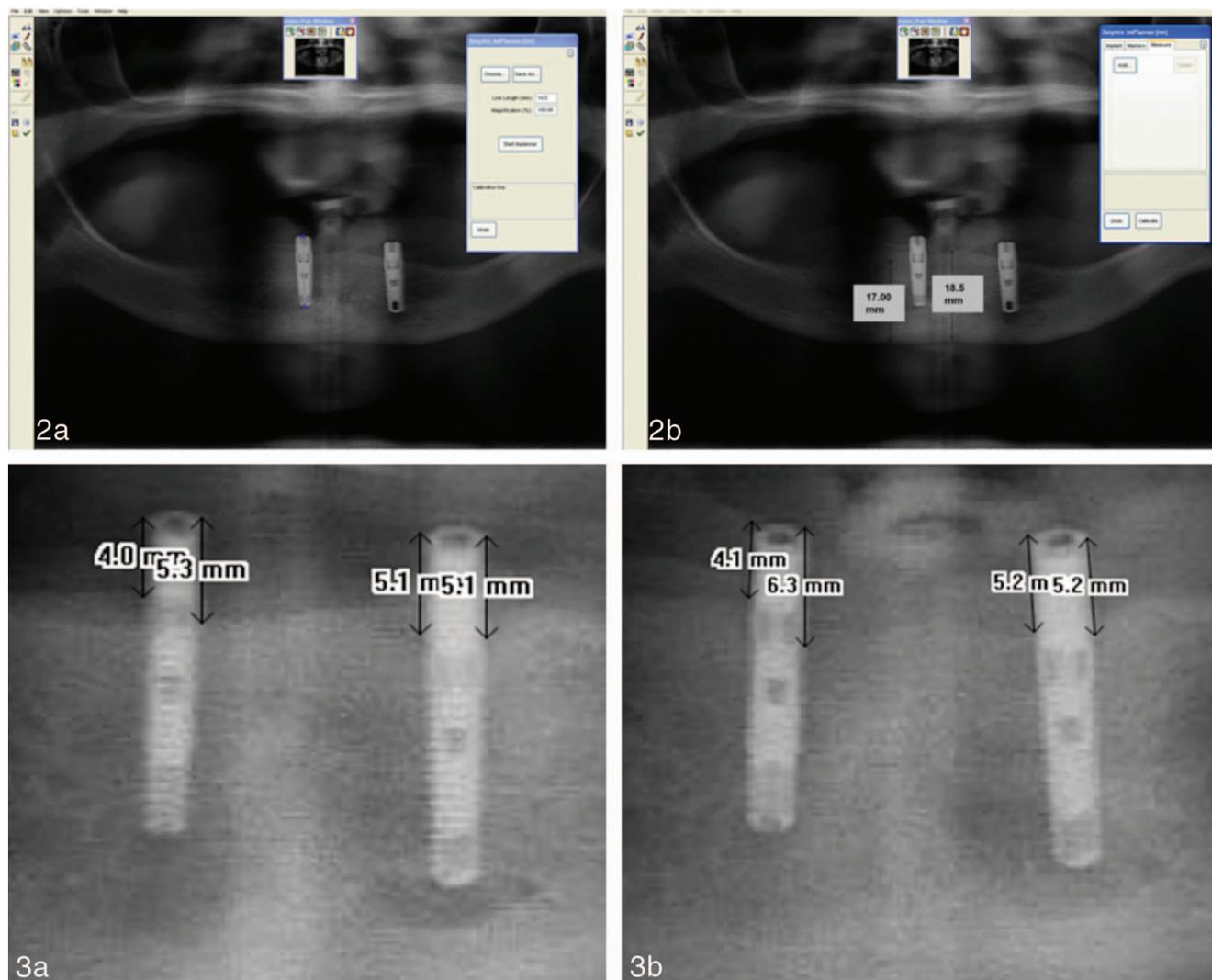
The nonparametric Kruskal-Wallis tests were used to test for significant differences between different time points. When significant differences were detected, pairwise comparisons were made between all the groups using the post hoc Wilcoxon signed rank test. The chosen level of significance for all statistical tests was $P < .05$. Statistical computation was performed using SPSS12.0 software (SPSS Inc, Chicago, Ill).

RESULTS

Two implants were lost in 1 subject, and 1 subject died for causes unrelated to the study. Of the 48 remaining subjects, 45 have had their implants restored with overdentures. The overall implant success rate was 97.7% at the 24-month follow-up.

Gingival index, plaque index, pocket depth, and mobility

There was no statistical difference at different follow-up visits regarding the gingival index or plaque scores (Table 1; $P > .05$). For pocket depth, the highest value, 2.13 ± 0.95 mm, was seen at the 24-month follow-up. There was no implant mobility at any time point.



FIGURES 2–3. FIGURE 2. Image analysis software was calibrated, referring the known implant and abutment length. (a) Calibration using Dolphin 3D imaging 11.5 (Patterson Dental Supply). (b) Measurement of the anterior mandibular height. **FIGURE 3.** Measurement of peri-implant bone resorption in the distal and mesial implant wall. (a) Immediately after placement. (b) Two years after placement. The mean (SD) bone loss at 2-year follow-up was 0.33 (0.48) mm overall, 0.63 (0.3) and 0.41 (0.5) mm at the mesial and distal side of #22, and 0.23 (0.3) and 0.11 (0.3) mm at the mesial and distal side of #27, respectively.

Radiographic bone loss

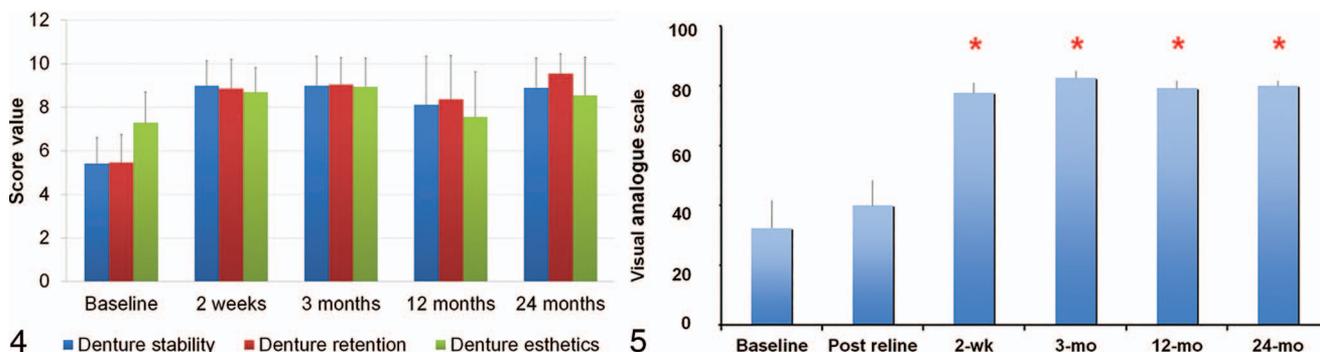
As shown in Figure 3, overall bone loss was 0.33 ± 0.48 mm at the 2-year follow-up visit. There was no statistically significant difference in bone loss between different time points ($P > .05$).

Time	Gingival Index	Plaque Score	Pocket Depth, mm
2 wk	0.93 ± 0.46^a	1.16 ± 0.76^a	1.74 ± 0.91^a
3 mo	1.00 ± 0.40^a	1.30 ± 0.72^a	1.86 ± 0.84^a
12 mo	1.08 ± 0.31^a	1.34 ± 0.75^a	1.76 ± 0.74^a
24 mo	1.07 ± 0.25^a	1.36 ± 0.75^a	2.13 ± 0.95^b

*Values followed by the same superscripts are not significantly different from each other ($P > .05$; Kruskal-Wallis and post hoc Wilcoxon signed rank test).

Overdenture prosthesis evaluation

Overdenture stability, retention, and esthetics were evaluated based on a scale of 0 (*poor*) to 10 (*excellent*; Figure 4). Although there were no statistical differences among the 2-week, 3-month, and 24-month follow-up visits, the values of all 3 categories decreased from the 2-week to the 12-month follow-up visits but increased at the 24-month follow-up visit. The reason that the lowest value was seen at the 12-month follow-up is because 29% (13/45) of the overdentures needed relining at this visit. Denture relining at this visit may have resulted in improved stability and retention scores at the 24-month follow-up. Complications of overdenture prosthesis are listed in Table 2, which includes the need for overdenture relines (29%), overdenture acrylic base fracture (4%), denture tooth fracture (2%), abutment screw loosening (2% incidence), and loss of retention of the locator male (11%),



FIGURES 4–5. **FIGURE 4.** Evaluation of 2-implant retained overdenture prosthesis by experienced providers. **FIGURE 5.** Patients' overall satisfaction with the 2-implant retained overdentures (n = 45). *Statistically significant as compared with baseline, $P < .05$.

Patient overall satisfaction

The subjects' overall satisfaction with fit and their ability to bite and chew hard food with their mandibular dentures improved significantly ($P < .05$) after the denture was attached to the dental implants. The patient overall satisfaction was rated as 32.4 at the baseline, increased to 40 after relin, and increased to 77.7 at 2 weeks after the overdenture was delivered, and it remained high until the 24-month follow-up visit (Figure 5).

DISCUSSION

The findings of the present study indicate that the 2-year success rate of IRMOD is high when both the surgeries and the restorations are performed by novice general dentistry residents. The success rate for implant surgery was 97.7% when measured with widely accepted clinical and radiographic standards, which is comparable with that reported in the current literature. Patient satisfaction with the function and esthetics of the overdentures was also comparable with that reported by specialist clinicians.

When compared with complete dentures, IRMOD provide edentulous patients with a higher quality of life because of their superior retention and stability, improved function and esthetics, and reduced alveolar ridge resorption. These characteristics improve the patient's ability to chew and speak, which is a common complaint associated with complete dentures.^{26–28} The success and success rates of dental implants placed by specialists have been well documented in numerous

studies. Cooper et al²⁹ stated that the success rate of 2-implant IRMOD was 95.9% from 6 to 60 months. The changes in marginal bone levels were positive (bone gain) but did not reach statistical significance at 12, 36, or 60 months ($+0.13 \pm 0.59$ mm, $+0.23 \pm 0.66$ mm, and $+0.09 \pm 0.79$, respectively). The patients' satisfaction with their teeth increased from a preoperative level of 12.1% to 94.6% at overdenture abutment connection and remained high (81.6%) after 5 years. Rutkunas et al³⁰ conducted a systemic review and concluded that the success rate of the 2-implant IRMOD ranged from 83% to 100% in the conventional loading group and from 71% to 100% in the early loading group. During the first year in the conventional group, the marginal bone loss ranged from 0.35 to 0.91 mm. It was noticed that the probing depth around conventionally loaded implants slightly decreased from 1.62 mm to 1.56 mm, while around early-loaded implants, it increased from 1.7 mm to 1.82 mm. The result from the study with implants placed and restored by novice dentist compares favorably with these studies.

With the increasing popularity of IRMOD and with the expert panel recommendation that IRMOD is the first choice for the edentulous mandible, its incorporation into the pre- and postdoctoral dental curricula will provide students with much needed clinical practice. Nevertheless, like most new health care technologies, implant overdenture treatment is still slow to diffuse into practice. For this treatment to become standard of care, it should also be provided by more general dentists, who are the same clinicians who provide the great majority of conventional dentures. However, few general dentists currently do so. This may be because of reasons such as time needed for training, perceived difficulty of training, and fear of liability. These negative attitudes are reinforced by assertions that general dentists do not have adequate skills to carry out what are presumed to be technically challenging procedures.³¹ In addition, little is known about the success rate of IRMOD placed and fabricated by novice general dentists. Our study has added valuable data to this topic. The success rate of the implant surgeries was high, and patient satisfaction with chewing, retention, speech, and overall impression of the IRMOD remained high at the 2-year follow-up in the present study. These findings support the incorporation of implant surgery and restorations in pre- and postgraduate training programs, as the benefits outweigh the risks when implants are placed and

TABLE 2

Clinical complications with 2-implant retained mandibular overdentures

	Number Affected/Placed	Incidence, %
Overdenture relines	13/45 prosthesis	29
Overdenture acrylic base fracture	2/45 prosthesis	4
Denture tooth fracture	1/45 prosthesis	2
Abutment screw loosening	2/90 implants	2
Overdenture loss of retention (replace the locator male)	10/90 implants	11

restored by novice general dentistry residents, as shown by the findings of the present study.

In this study, some common prosthetic complications were seen in study patients such as retention, wear, loosening of the abutment screw, and fracture.^{32–34} The most common complication in this study was food impaction under the anterior area of the denture due to the surgery procedure and subsequent ridge remodeling. A chair-side relines of the overdenture was necessary in 29% of the patients at 12-month follow-up, which also explains why the lowest value of prosthesis stability and retention was seen at 12 months, and the values increased and remained high at 24 months. The primary reason for the high incidence of denture relines is that all of the complete dentures were fabricated soon after the extraction of remaining mandibular teeth. Remodeling of the mandibular alveolar ridge following extractions and denture installations rendered it necessary for relines at 12-month follow-up. The second most common complication (11%) was the wear of the locator male and subsequent loss of retention. Loosening of abutment locator (2%) and denture fracture rate (4%) were lower than in a previous study on IRMOD.³² A denture fracture was seen at the central incisor area in 1 patient. This patient had a relatively small jaw and small denture. To minimize the fracture risk, a metal bar was embedded in the repaired denture.

In addition, an interesting phenomenon was observed in this study in relation to implant hygiene. Thorough hygiene instruction was given at the beginning of the study and reinforced again at each follow-up appointment, which enabled the gingival index and plaque scores to remain at a consistent desirable level, as no statistical difference was seen at different follow-up appointments. Good implant hygiene, in addition to proper patient selection, treatment planning, implant placement, and overdenture restoration, is very important in reducing the risks of peri-implant infections and avoiding bone loss and increased probing pocket depth. The results suggest that patient could keep decent implant hygiene as long as the hygiene instruction is given properly at the beginning of the treatment and reinforced at each visit. An annual maintenance appointment is therefore warranted for IRMOD patients.

CONCLUSIONS

We conclude that novice general dentistry residents can successfully complete the surgical and the restoration phases of implant-retained mandibular overdentures. Implant surgeries involving 2 implants at the mandibular intraforaminal area are highly successful and predictable when performed by novice general dentistry residents, as indicated by the 97.7% success rate, and patient overall satisfaction with the IRMOD remained high after 2 years in function. As this study was done in a single AEGD program and the sample size was relatively small, more studies with a similar design are needed to corroborate the findings.

ABBREVIATIONS

AEGD: Advanced Education in General Dentistry
 IRMOD: implant-retained mandibular overdentures
 PPD: pocket probing depth

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