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# Implant-Retained Removable Partial Dentures: An 8-Year Retrospective Study

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**Keywords**
Patient satisfaction; removable prostheses; esthetic dentistry; diagnosis.

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Accepted June 1, 2010

doi: 10.1111/j.1532-849X.2011.00700.x

## Abstract

**Purpose:** To evaluate the long-term outcomes of removable partial dentures (RPDs) retained (but not supported) by dental implants.
**Materials and Methods:** We retrospectively evaluated 32 consecutive patients who received implant-retained RPDs. Each patient received one to four endosseus implants; the sample included a total of 64 implants. Follow-up was conducted for a minimum of 8 years, during which satisfaction, implant survival, and prosthetic success were evaluated.
**Results:** Patient satisfaction systematically increased. The implant success rate was 93.75%, and 100% of the prostheses were successful.
**Conclusion:** Implant-retained RPDs are a reliable intermediate solution that can reduce biological and economic costs while maintaining implant treatment benefits and the ease of RPD procedures.

The number of partially edentulous working-age patients will soon increase.[1] Prosthodontic medicine aims to achieve acceptable masticatory and phonetic abilities, adequate esthetics, and patient comfort. Standardized and simplified protocols that are easily managed by most practitioners will facilitate the attainment of these goals.

The incidences of caries and periodontitis have decreased in recent decades due to prevention policies, improved dental procedures, and more frequent early diagnosis by practitioners and patients. The number of totally edentulous working-age patients is decreasing, and 72% of extracted teeth are molars and premolars.[2] Indeed, 73% of partially edentulous patients who seek treatment present with missing molars and premolars; 40% are bilateral Kennedy Class I cases, and 33% are monolateral Kennedy Class II cases.[3]

When only a few teeth are absent, they are usually replaced with fixed partial dentures (FPDs) or left without replacement. The likelihood of a removable restoration increases with the number of teeth to be replaced. Higher frequencies of removable restorations are found in older age groups, subjects living in rural areas, and individuals of low socioeconomic status, education, and income levels. While the frequency of oral implant use is increasing, it remains low (2% to 4%). Researchers have noted the increased use of fixed restorations and removable partial dentures (RPDs), accompanied by a reduction in the use of complete dentures.[4] The mean number of lost teeth increases with age, and many dentate subjects aged 60 years or more have reduced dentitions requiring prosthodontic treatment.[5] We may therefore expect that the next decade's typical patient needing prosthetic rehabilitation of missing posterior teeth will be of postretirement age and have limited economic resources.

Various approaches, from no treatment at all to complex multidisciplinary treatments, have been used to manage Kennedy Class I and II partial edentulism. The choice of treatment depends on factors such as the patient's local and systemic health, his or her desires and compliance, economic feasibility, and the skill of the dental practitioner. An effective and reliable treatment solution is often a compromise that uses simple technology to fulfill the patient's expectations.[6–8] The combined use of implants and RPDs to obtain a Kennedy Class III configuration has been described in the literature.[9–16] Chikunov et al[17] suggested that implant-retained partial overdentures with

**Table 1** Patient characteristics

| No. of patients | Mean age | Kennedy classification | Location | Implants inserted | Follow-up | Unsuccessful or removed implants | Implant success rate |
|---|---|---|---|---|---|---|---|
| 32<br>18 male<br>14 female | 56.8 years | I: 19<br>II: 10<br>III: 3 | 21 max.<br>11 mand. | 64 | 8 years | 4 | 93.75% |

resilient attachments are a predictable and cost-effective treatment option for partially edentulous patients.

Al-Johany and Andres[18] proposed the implant-corrected Kennedy classification system for RPDs in partially edentulous arches with implants. This system incorporates the number and positions of implants placed in edentulous areas.

Here, we present a treatment option for partial edentulism that is easy, effective, and economical. Because it requires a limited number of implants and avoids additional treatment of residual teeth, the treatment meets these qualifications. Termed the implant-retained removable partial denture (IR-RPD), it is a modified standard RPD connected to dental implants by ball attachments. The IR-RPD enhances the dentomucosal model of masticatory force transmission characterizing traditional RPDs with distal extensions.

## Materials and methods

Our study sample was drawn from 172 partially edentulous patients, who presented for dental restoration between September 1998 and July 2000. They were consecutively treated in the prosthetic dentistry departments of the University of Modena and Reggio Emilia and the University of Ferrara, Italy. The study was authorized by the directional board of the Department of Integrated Activities of Specialized Head-Neck Surgery, Research and Development Center of Diagnostic Methods in Therapeutic Reconstructive Surgery, Dental Materials and Implant Prostheses, University of Modena and Reggio Emilia, Italy.

The first examination included a complete screening for diseases affecting oral rehabilitation, a dental anamnesis, plaster casting, photography, and panoramic radiography. Rehabilitation options were exhaustively discussed during the second visit. These included (when not contraindicated) traditional FPDs or RPDs, IR-RPDs, and implant-supported (IS-)FPDs with or without alveolar reconstructive surgery. Each patient provided informed consent to the selected treatment.

Of the 172 patients, 53 selected IR-RPDs. This study included 32 (18 men, 14 women) of these patients, who already wore traditional RPDs and could thus comment on differences between the treatment protocols. The patients presented with unilateral or bilateral distal edentulism (n = 29), or Kennedy Class III partial edentulism (n = 3).

The study sample was divided into three groups based on Kennedy classification (Class I = 19, Class II = 10, Class III = 3). A total of 64 implants (Branemark MKIII; Nobelpharma AB, Göteborg, Sweden) were inserted. We used the largest diameter and longest implants allowed by the edentulous alveolar ridge, and maintained each implant parallel to the denture insertion axis that had been determined based on the master casts (Tables 1–3).

Maxillary implants were loaded after 6 months, and mandibular implants were loaded after 3 months. The implants primarily functioned as retention elements connected to the dentures with a resilient ball attachment (Sphero Block Normo System, 2.5-mm diameter with resilient cap; Rhein 83, Bologna, Italy).

Proper design of the IR-RPD was essential, because the use of implants did not entirely replace the function of elements, such as the insertion axis, attachment position, rests, auxiliary clasp assemblies, and framework. The preferred maxillary major connector was the palatal plate, while that for the mandible was the lingual bar.

The occlusal scheme focused on mutual protection when anterior teeth were present, and on balanced occlusion when complete dentures served as antagonists. The final appointment included intraoral evaluation of the occlusion, maintenance instruction, and oral and written presentations of each patient's recall schedule.

Follow-up on all patients was conducted annually for at least 8 years. The following evaluations were made during follow-up examinations:

- Patient satisfaction after 1 year;
- Implant success (clinical observation of attachments and periimplant tissues, radiography);
- Denture compliance, occlusal stability, and necessity of relining.
- Retention of the attachment.

**Table 2** Implant positions

| Implant position | Maxilla | Mandible |
|---|---|---|
| Lateral incisor | 1 | 0 |
| Canine | 21 | 10 |
| First premolar | 14 | 9 |
| Second premolar | 6 | 3 |

**Table 3** Implant sizes

| Branemark MKIII—Nobelpharma<br>Implant size (mm) | Number of implants |
|---|---|
| 3.75 × 10 | 8 |
| 3.75 × 11.5 | 15 |
| 3.75 × 13 | 22 |
| 3.75 × 15 | 15 |
| 5 × 10 | 2 |
| 5 × 11.5 | 2 |

**Table 4** Patient satisfaction before and 1 year after treatment

| | Satisfaction before treatment (1–5) | Satisfaction after treatment (1–5) |
|---|---|---|
| Mean | 1.31 | 4.59 |
| Standard deviation | 0.43 | 0.47 |

The resilient component of the attachment was annually replaced, regardless of wear. This procedure was usually performed easily and rapidly. Patient satisfaction was measured by questionnaire, using a discrete scale of 1 to 5 (1 was the worst). Satisfaction levels were recorded before prosthesis delivery and 1 year after IR-RPD insertion. Periimplant bone resorption was evaluated with annual intraoral radiographs, using a parallel ray technique. While we risked some quantitative imprecision by not standardizing the patient's exact position for each image, this evaluation sought to qualitatively assess periimplant bone maintenance. The fit of the distal extensions to the residual ridges was evaluated with a specific pressure-indicating silicone paste (Fit Checker, GC Europe, Leuven, Belgium), and relined when appropriate.

## Results

Patient satisfaction is summarized in Table 4. The overall implant success was 93.75% (4/64 failures; Table 1). These failures did not require refabrication of the prostheses. The overall success of IR-RPD rehabilitation was therefore 100%. Prosthetic complications and maintenance are summarized in Table 5.

## Discussion

### Patient satisfaction

Like other prosthetic treatment options, the goals of IR-RPD use are adequate masticatory and speech ability and acceptable esthetics. Patients are usually concerned primarily and sometimes solely with esthetic outcomes. Any prosthetic rehabilitation should also integrate with the stomatognathic system without disturbing the residual tissues and structures.

Our results demonstrated a systematic increase in patient satisfaction after receiving an IR-RPD (Table 4). This increase in satisfaction was probably due to the comfort of the prosthesis and improved esthetics of the rehabilitation. Consideration of the satisfaction data, however, must take into account the recruitment of the study sample; all patients evaluated in this study presented requesting new prostheses because they were not satisfied with their current RPDs. The increases in patient satisfaction are thus probably overestimated.

**Table 5** Prosthetic complications and maintenance

| | |
|---|---|
| Loose abutment | 2 cases in 2 patients in 8 years |
| Tooth substitution | 29 times in 24 patients in 8 years |
| Relining | 93 relinings in 32 patients in 8 years |

Resilient components were replaced annually.

### Implant and denture evaluation

Ball attachments were lost in two cases (Table 5). The periimplant soft tissues and marginal gingiva of most patients were slightly inflamed. In almost every case, we proceeded to professional prophylaxis and instructed the patients to more diligently perform home maintenance. Several edentulous ridges exhibited traumatic inflammation or small ulcers. The compression areas on the denture bases were trimmed in these cases.

Evaluation of the dentures included examination of the bases and assessment of dental attrition. The teeth of some patients with parafunctional habits were replaced. Relining needs (Table 5) were evaluated with pressure-indicating silicone. An average of one denture was relined every 2.75 years. The first relining was often performed in the first year. Most patients underwent multiple extractions before receiving IR-RPDs; most resorption occurs during the first months after extraction, stabilizing or slowly progressing thereafter.

A nonintegrated implant was detected and removed during the second-stage surgery of two patients (female patient No. 3 and male patient No. 18). Deficient bone quantity and quality dictated the insertion of more than two implants in the first case; the treatment was therefore completed without replacing the nonintegrated implant. In the second case, a replacement implant was positioned in the same site after a healing period of 3 months and allowed to heal while submerged. The IR-RPD was completed and adapted to this newly inserted implant.

Two integrated implants (male patient No. 6 and female patient No. 7) failed during the 8-year follow-up period, according to the criteria of Lekholm and Zarb.[19] These failures were due to excessive bone resorption in the first 2 years; resorption tended to be minimal thereafter. Although some threads remained exposed to the oral cavity, the fixtures remained integrated and functional in these cases. Patients with Kennedy Class I or II edentulism characterized by a large number of missing teeth are typically more demanding of esthetic or functional outcomes than edentulous patients with less tooth loss.

A majority of implants in this study were located in the canine or first premolar positions (Table 2). This distribution was expected for two main reasons: adequate bone quantity and quality are more likely to be present at these sites, and patients are more likely to have lost multiple teeth in these locations, thus requiring a rehabilitation plan that includes implants. The implant distribution by site also explains the distribution of implant sizes (Table 3), characterized by a high frequency of medium and long implants (13 and 15 mm in length).

Based on our experience, the typical indications for IR-RPD are:

- Kennedy Class I or II edentulism with one or no canine;
- Kennedy Class I or II edentulism with worn remaining dentition;
- Bilateral Kennedy Class III edentulism with a long distal extension;
- Kennedy Class IV edentulism with a long extension;
- Patient refusal of fixed or combined fixed/removable dentures;
- Patient refusal of complete palatal coverage;

- Patient refusal of clasp assemblies for esthetic reasons;
- Healthy but reduced periodontal tissues (resolution of periodontal treatment);
- Insufficient retention for existing RPDs;
- Intermaxillary (sagittal, frontal, and occlusal) relationship contraindicating an FPD.

Distally edentulous maxillae that exhibit instability or absence of both canines may be rehabilitated with traditional RPDs; however, clasp assemblies that engage the anterior teeth or combined fixed/removable dentures with precision attachments require the preparation of remaining teeth and endodontic treatment. These biological and financial costs can be considerable.

The bilateral placement of single implants distal to the abutment teeth can provide a posterior rotational axis for the biomechanical system. This method also avoids invasive preparation of the remaining teeth, because they are used only for indirect retention.

The primary prosthetic and biomechanical characteristics of IR-RPDs are:

- Enhancement of load distribution;
- Posterior rotational axis;
- Shorter distal extensions;
- Rotational potential of the distal extension;
- Further enhancement of the biomechanical system by correct use of guide planes and proximal parts of the framework;[20]
- Ability to use different retention types, as proposed by Graser and Rogoff.[21]

Implants are often used in partially edentulous patients solely for the fabrication of FPDs. Implant use requires sufficient residual alveolar bone volume for the insertion of standard-sized implants and the correction of maxillomandibular relationships. Distal resorption frequently creates contraindications of anatomical structures, such as the inferior alveolar nerve and the maxillary sinus. Bone grafting is required before implant placement in patients with such resorption, compounding biological and economic costs and increasing the risks of complication and failure.[22–25]

Traditional RPDs are an option for patients who refuse or cannot afford major surgery. The IR-RPD is an intermediate solution aiming to reduce biological and economic costs while maintaining the benefits of implant treatment and the ease of RPD procedures. This option reduces the number of implants needed for a fixed prosthesis, and provides retention for the RPD. It eliminates the need for clasp assemblies in esthetically sensitive zones and preparation of anterior teeth for combined fixed/removable partial dentures. The ball attachments that comprise the implant retention system strategically replace missing abutment teeth, constituting a simplified RPD design and often reducing the need for full palatal coverage. The absence of clasp assemblies and the choice of abutment teeth replaced by the implant retention system differentiate an IR-RPD from a traditional RPD.

IR-RPDs are thus a valid alternative to traditional RPDs. This technique requires a surgical approach that targets sites with adequate bone volume, avoids proximity to vital structures, and can be managed by dentists who perform implant procedures. This treatment modality offers an easier way to reach biological, functional, esthetic, and economic goals without changing the masticatory model of dentomucosal transmission of forces, which is guaranteed by the rotational ability of the implant retention system.

## Conclusions

Within the limitations of this study, we have reached the following conclusions:

(1) The combined use of implants and traditional RPDs increases patient satisfaction;
(2) Periimplant soft tissues and residual edentulous ridges remain stable over time;
(3) Bone resorption around the implants is within acceptable limits and is comparable to that seen with standard implants.[26–33]

A rational approach to distal partially edentulous conditions must consider the following issues:

(1) The need to replace missing molars versus the adoption of a shortened dental arch;
(2) The option of using an FPD;
(3) Implant options and indications;
(4) Indications for traditional RPDs;
(5) The patient's expectations, desires, and financial considerations.

The length of treatment, physical and psychological requirements, and higher risks of failure associated with complex treatment plans can overwhelm patients and decrease their compliance and satisfaction. The IR-RPD rehabilitation option is a compromise allowing patients who are not suited to a complex treatment to easily reach prosthetic goals (correct masticatory, esthetic, and phonetic functions). This treatment can also be strategically used to spread a complex treatment over time, thus increasing the physical and economic chances of success. IR-RPDs can constitute an interim treatment option while dentists and patients make decisions about the extraction of minimally compromised teeth, and can later be transformed into a complete implant-sustained overdenture.

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