

## Prospective clinical study of prosthetic treatment outcome of implant-retained-removable-partial-denture during 5 year-follow-ups

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### RESEARCH

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### ABSTRACT

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#### Background

IRRPD offers patients the ability to upgrade their treatment planning to implant-supported-overdentures (ISOs) or implant-supported-fixed-prostheses (ISFPs) through insertion of more implants in the future after the loss of the remaining natural teeth.

#### Aims

The purpose of this prospective-clinical-study was to evaluate the success rate and treatment outcome of IRRPD for 15 patients, during at least 5-year-follow-ups after prosthetic rehabilitation with respect to implant mobility, peri-implant-marginal-bone-levels, and prosthetic complications.

#### Methods

15 successive patients were attended the Department of Implantology and Prosthodontics in TUMS, and received Implant-Retained-Removable-Partial-Dentures (IRRPDs). Two standard-size-dental-implants (Implantium/Dentium system, internal hexagon, Seoul, South Korea) were placed in distal-extension-areas for each patient. After the

osseointegration period, all patients received IRRPDs using two Ball attachments. All the participated patients were followed-up at least for 5 years, and the survival rate of 30 implants was evaluated. The patients' satisfaction of function, phonetics, and aesthetics was assessed by means of questionnaire.

#### Results

None of the studied patients reported any prosthetic complications during the follow-up-periods such as attachment loosening, metal housing loosening, or denture fracture. No implants failure was recorded, so that the cumulative-implant-survival rate was 100 per cent. The mean marginal-bone-resorption (MBR) around the two implants was 0.9mm with a range of 0.5–1.4mm. Teeth aesthetics was judged as excellent or very good by 86.7 per cent of the patients, while phonetics and mastication were considered excellent or very good by 66.7 per cent and 73.3 per cent of the patients, respectively.

#### Conclusion

15 patients received 30 implants for the fabrication of IRRPDs in the posterior-edentulous-sites. The IRRPDs were delivered to the patients by the same practitioner. After 5-year-follow-ups-schedule, this prospective-clinical-study supported the use of IRRPDs in the posterior region when the patients cannot afford more implants insertion for the construction of ISFPs.

Within the limitation of this study, the following conclusions can be drawn:

1. The survival rate of all 30 implants was 100 per cent.
2. No prosthetic complications were occurred during 5-year-follow-ups-period.
3. IRRPDs treatment option should be encouraged to be used in the posterior-edentulous-sites as an alternative option to ISFPs.
4. IRRPDs can provide appropriate function, phonetics, and aesthetics.

**Key Words**

Dental implant, implant-supported denture, denture precision attachment, removable partial denture

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**What this study adds:****1. What is known about this subject?**

In this clinical study, the authors reported the use of IRRPD treatment modality for distal-extension-partially-edentulous patients as a valuable-clinical-option.

**2. What new information is offered in this study?**

The successful use of IRRPDs in partially-edentulous-patients with neither implants failure nor prostheses complications after especially long-term-follow-ups, showed that this treatment modality can offer appropriately-acceptable-results.

**3. What are the implications for research, policy, or practice?**

IRRPD treatment option can improve the quality of life of patients by enhancing their chewing efficacy compared to conventional RPDs, and can be considered as a cost-effective-choice compared to ISFPs.

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**Background**

There are several treatment options to restore partial edentulism including: implant-supported fixed prostheses (ISFPs), fixed partial dentures (FPD), conventional removable partial dentures (CRPDs),<sup>1</sup> and implant-retained removable partial dentures (IRRPDs). Each of these prosthetic approaches has inherent risks and benefits.

ISFP is considered the best treatment modality. But it may not be used due to several reasons such as; loss of supporting tissues, compromised medical and oral health, general surgical protocol, intra-oral anatomical limitations, excessive inter-occlusal space, and financial problems.<sup>2,3</sup>

FPD is not always possible mainly when patients have distal-extension-areas either unilateral or bilateral (Kennedy Class I or II). Also FPD is not indicated in patients who do not accept abutment-teeth-preparation.

Some of the problems associated with CRPDs include excessive-vertical-displacement of prostheses, minimal retention, periodontally-compromised-abutment-teeth, and inaeesthetic clasps.<sup>4</sup> Another detrimental effect of CRPDs with remaining mandibular-anterior-teeth (i.e., mandibular Kennedy Class I) opposing maxillary-complete-denture (CD) is "combination syndrome" occurrence.<sup>5-8</sup>

IRRPD is one of the possible treatment alternatives for rehabilitation of partial edentulism, which can alter Kennedy Class I/II situations into Kennedy Class III.<sup>2,9-14</sup> Advantages of IRRPDs include increasing the retention, support, and stability of RPDs, enhancing chewing efficiency and nutrient intake,<sup>15</sup> improving function, reducing posterior-residual-ridge-resorption,<sup>16</sup> improving patient's satisfaction,<sup>13</sup> and cost benefit compared to ISFPs. Other advantages of IRRPDs are better-hygiene-access, improved speech, and aesthetics in some patients when compared to fixed prostheses.<sup>17</sup>

**Methods****Patients selection criteria**

Fifteen successive patients were selected from the patient population attended the Implantology and Prosthodontics Department at Tehran University of Medical Sciences (TUMS). Age and gender distributions of the patients' are presented in Table 1. The presurgical evaluation included clinical and radiographic (periapical and panoramic radiographies) examinations. All 15 patients were informed about the study design and approved to participate. The patients were selected according to the following criteria.

- No systemic contraindications for oral-surgical-interventions,
- Partially-edentulous-sites in the maxillary/mandibular-posterior-regions (Kennedy Class I),
- Presence of adequate-bone-width precluding the need for bone-augmentation-procedures,
- Approximately similar bone height at the implant sites, which might allow for the placement of implants with similar height and diameter,
- Occlusal scheme allowing for the establishment of bilateral-balanced-occlusion contacts.

**Clinical procedure**

After case selection, 30 standard-size implants (Implantium/Dentium system, internal hexagon, Seoul, South Korea) were placed using two-stage-surgical-technique for 15 patients. A practitioner carefully performed all the surgeries. The edentulous sites and the implants lengths and diameters are summarized in Tables 2 and 3.

Four months after placement of the implants second-stage-surgery was performed and the titanium-healing-abutments were connected. The primary impression was taken 2 weeks after the second-stage-surgery using irreversible hydrocolloid (Kromopan, LASCOD, Italy). After custom tray fabrication, the edentulous areas were border

molded. Additional silicone (AS Panasil Monophase, Kettenbach GmbH, Eschenburg, Germany) was used for taking the final impression. Prior to the impression procedure, pick-up impression-copings (D:4mm×H:17mm, Pick-up Copings, Dentium, Seoul, South Korea) were secured to the implants fixtures. Five minutes were allowed for setting of the impression material, after which the coping screws were unscrewed and the impressions removed from the patients' mouths. Implant replicas (DANSE, Dentium, Seoul, South Korea) were screwed on top of the impression copings, and the impression was poured with type IV dental stone (New FujiRock; GC Corporation, Tokyo, Japan) following the manufacturer's instructions. All laboratory procedures were performed by the same technician. Ball abutments (Rheine83 system, New Rochelle, NY, USA) were selected for all patients according to the available inter-occlusal-space. At the delivery procedure the ball attachments were seated intra-orally, and torqued according to the manufacturer's instructions (20Ncm). The IRRPD design included the retentive clasps to improve the retention especially during bite-registration-appointment. The metal housings were inserted using chair-side-procedure with pink-self-cured-acrylic in order to increase the durability of the plastic caps. The occlusal scheme was bilateral-balanced-occlusion in all patients (Figure 1A and 1B). After delivery of the IRRPDs a follow-up schedule was proposed for all patients. According to this schedule, the patients should be followed-up every 3 months in the first year and every 6 months in the subsequent years at least for 5 years. All patients regularly returned to the department for follow-ups (Figures 2 and 3). The implant-survival-rate was estimated according to the following criteria:

- Absence of mobility,
- Absence of painful symptoms or paresthesia,
- Absence of peri-implant-radiolucency during radiographic evaluation,
- Absence of progressive-marginal-bone-loss.

The patients' satisfaction for function, aesthetics, and phonetics was assessed by means of a questionnaire, delivered at the 1-2, 3-, 4-, and 5-year visits. The answers were based on a 5-point Likert-type scale, ranging from 1 ("poor") to 5 ("excellent"). Questionnaires were returned postage-paid. At all follow-up visits, the IRRPDs were removed and the stability of each implant was tested. The evaluated criteria for the present study were:

1. **Prosthesis stability:** when the IRRPD was in function, there was no mobility or pain.
2. **Prosthesis failure:** when the IRRPD should be remade for any reason.

3. **Implant survival:** when there was no evidence of peri-implant-radiolucency, suppuration and/or pain at the implant site, and the absence of neuropathy or persistent paraesthesia.

## Results

All the patients completed the study-follow-ups-schedule. No patient reported any prosthetic complications, such as loosening of the ball attachments, loosening of the metal housing, fracturing of the clasps, and acrylic-denture-base or acrylic teeth fracture.

Bone qualities of the implants sites were evaluated at the time of implant insertion. 20 implants were placed in type I bone, 8 implants were placed in type II bone, and 2 implants were placed in type III bone according to Misch classification. Clinical evaluation of the peri-implant-mucosa with the periodontal indices revealed satisfactory results during all follow-ups-visits Table 4. The status of the soft tissue around the implants and remaining teeth remained stable over the evaluation period. Dental plaque was present on 11 per cent of the considered surfaces, and gingival inflammation was observed only in 3.8 per cent of all cases. Keratinized-attached-gingiva was present in 94 per cent of the buccal surfaces, and in 92.5 per cent of the lingual surfaces of the studied implants. Probing was carefully accomplished; only a few percentages of the sites (5 per cent) had bleeding-on-probing. Marginal-bone-resorption (MBR) at 5 years after implants placement was measured from the apical end of the smooth collar of the implants to the crest of the ridge using parallel-periapical-radiographs. The mean MBR was 0.9mm with a range of 0.5–1.4mm. No implants failure was recorded to date, so that the cumulative-implant-survival rate was 100 per cent (Table 5). All the delivered IRRPDs were functional and stable. No adverse experience was observed. All patients filled in the questionnaires at 4-visit-follow-ups, which is depicted in (Table 6). Teeth aesthetics (mold, color, and shape of the teeth) was judged as excellent or very good by 86.7 per cent of the patients, while phonetics and mastication were considered excellent or very good by 66.7 per cent and 73.3 per cent of the patients, respectively.

## Discussion

The current prospective-clinical-study evaluated 30 implants (15 patients) used for IRRPDs in the maxillary/mandibular Kennedy Cl I patients for at least 5 years.

The results did not reveal any prosthetic complications at

the end of the assessment period. None of the implants failed after 5-year-follow-ups. The patients expressed high level of satisfaction concerning mastication, phonetics, and aesthetics. A common prosthodontic challenge in bilateral – distal-extension RPDs is lack of support, retention, and stability. Furthermore, controlling the detrimental forces on abutment teeth and the residual ridge of posterior mandible is a great concern. Implants can be placed in the distal-extension-areas for resolving these problems.<sup>18-26</sup> Patients and most clinicians generally prefer fixed prostheses. However, there are some situations in which IRRPDs may be considered as the only possible treatment option.

There is a general consensus in the literatures that IRRPD has so many advantages over conventional RPDs, which can be summarized as: 1) Improving retention, support, and stability, 2) Preventing or reducing the residual-ridge-resorption (RRR) rate, 3) Increasing the patient's satisfaction (Quality of Life), comfort, and chewing efficiency, 4) Improving aesthetics, because buccal-retentive-arm-clasps can be eliminated at the aesthetic zone, especially if additional retention can be achieved from implants by using attachments, 5) Reducing the effect of reciprocal arm, 6) Reducing the tissue-ward-movement, so that repeated relining of the IRRPD can be avoided or minimized, 7) Improving the position of fulcrum line, 8) Minimizing the implants number, so that it will be more cost-effective for patients with financial limitations compared to ISFPs, 9) Avoiding anatomical landmarks such as maxillary sinus or mandibular canal, is more easily possible. So that there is no need to sinus augmentation or nerve-repositioning-surgery, 10) Converting a Kennedy Class I or II RPD to a tooth-implant-supported RPD which may be considered as a Kennedy Class III, 11) Psychological benefit of preserving patient's natural teeth with less than optimal prognosis, at least for an interim period, 12) A "staged" approach in implant insertion may be performed according to patient's budget,<sup>3,14,18,20,26-30</sup> 13) Oral hygiene may be provided more easily than fixed prostheses and nocturnal bruxism can be reduced or eliminated due to its removal during night,<sup>12,31</sup> 14) In the case of greater crown-height-space (CHS) resulting from excessive RRR, macrotrauma or ablative surgery, IRRPD seems to be a better biomechanical option.<sup>19</sup>

## Conclusion

Fifteen patients received 30 implants for the fabrication of IRRPDs in the posterior-edentulous-sites. The IRRPDs delivered to the patients by the same practitioner. After 5-year-follow-ups-schedule, this prospective-clinical-study supported the use of IRRPDs in the posterior region when the patients cannot afford more implants insertion for the

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**CONFLICTS OF INTEREST**

The authors claim to have no conflict of interest and take responsibility for the content of the manuscript.

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**ETHICS COMMITTEE APPROVAL**

The study protocol was reviewed and approved by the Ethical Committee of Tehran University of Medical Sciences, Tehran, Iran (IR.TUMS.REC.2048.1396)

**Table 1: Patient Age and Gender Distribution**

Age	Male	Female	Total
40-50	3	5	8
50-60	3	2	5
70-80	1	1	2
Total	7	8	15

**Table 2: Distributions of Implants in Posterior Edentulous Sites Treated with IRRPDs**

Location	No. of implants
Maxillary molar region	14
Mandibular molar region	16

**Table 3: Dimension of implants used**

Dimensions (Length x diameter)	No. of implants
4.8x12mm	4
4.3x10mm	2
3.8x12mm	6
4.8x10mm	4
4.3x10mm	4
4.8x8mm	2
4.3x7mm	2
3.8x10mm	6

**Table 4: Periodontal Parameters Recorded by Dichotomous Records**

Periodontal Indices	Percentage
Presence of plaque	11
Gingival inflammation	3.8
Bleeding on probing	5
Amount of facial keratinized gingiva	94
Amount of lingual keratinized gingiva	92.5

**Table 5: Survival Rate Analyses of Implants**

Time Period (Months)	Implants in the Interval	Failed Implants	Cumulative Survival Rate
12-24 months	30	0	100%
24-36 months	30	0	100%
36-48 months	30	0	100%
48-60 months	30	0	100%

**Table 6: Results of the Evaluation of Questionnaires for 15 Patients' Satisfaction**

	1-2 year	3 year	4 year	5 year
<b>Function</b>				
Poor	0	0	0	0
Sufficient	6	1	5	0
Good	4	5	5	2
Very good	3	6	3	9
Excellent	2	3	2	4
<b>Aesthetics</b>				
Poor	0	0	0	0
Sufficient	7	6	5	3
Good	4	6	4	2
Very good	3	2	4	8
Excellent	1	1	2	2
<b>Phonetics</b>				
Poor	0	0	0	0
Sufficient	6	4	7	1
Good	3	4	3	3
Very good	3	4	1	8
Excellent	3	3	4	3

**Figure 1-A: Intaglio surface of mandibular IRRPD before delivery**



**Figure 1-B: Mandibular IRRPD after delivery visit**



**Figure 2: Mandibular IRRPD in position after 5-year recall**



**Figure 3: Mandibular IRRPD in function after 5-year recall**

