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Non-Cross-Arch Implant-Crown-Retained Removable Partial Denture With Segmented Short-Span Splinted Crowns and Occlusal-Rest-Free Ring Clasps for Maxillary Edentulism: A 4-Year Follow-Up Case Report

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Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
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Conflict of interest: None declared

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Patient: Male, 61-year-old

Final Diagnosis: Maxillary partial edentulism with chronic periodontitis

Symptoms: Missing maxillary left posterior teeth • reduced masticatory efficiency • mobility of the maxillary right anterior teeth • poor retention of the previous removable partial denture

Clinical Procedure: Tooth extraction, dental implant placement, and rehabilitation with an implant-crown-retained removable partial denture

Specialty: Dentistry

Objective: Unusual or unexpected effect of treatment

Background: This report describes an incremental design refinement of the implant-crown-retained removable partial denture (ICRPD) for maxillary edentulous rehabilitation, comprising a non-cross-arch configuration with segmented short-span splinted crowns and occlusal-rest-free ring clasps.

Case Report: A 61-year-old man presented with maxillary edentulism and dissatisfaction with his previous removable partial denture, which he had worn for 2 years with progressively deteriorating retention. Clinical and radiographic examinations revealed partial edentulism and chronic periodontitis. After initial periodontal therapy, teeth #13, #14, and #23 were extracted; implants were placed at sites #13, #14, #23, and #24. Following osseointegration, an ICRPD was fabricated using short-span splinted implant crowns and pure titanium ring clasps without occlusal rests. The prosthesis provided retention through implant crowns with combined implant-mucosal support. At the 4-year follow-up, probing depths were 1 to 3 mm without bleeding on probing. The patient reported high satisfaction; the OHIP-EDENT score (Chinese version) decreased from 5 to 2, and the visual analog scale pain score decreased from 3 to 0. Radiographic assessment showed marginal bone loss of 0.16 to 1.67 mm. Cone-beam computed tomography confirmed stable marginal bone levels. No biological or mechanical complications were observed.

Conclusions: This case demonstrates that the refined ICRPD design, incorporating occlusal-rest-free ring clasps and short-span splinted crowns, provided reliable retention and long-term stability over 4 years, without mechanical complications and with high patient satisfaction. These findings support the clinical feasibility of this design, which may represent a promising option for appropriately selected patients; it is hypothesized to reduce the prosthetic span and limit unfavorable load transmission to the implant necks.

Keywords: Case Reports • Dental Implantation • Denture Design • Denture, Partial, Removable

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Introduction

Given the accelerating global trend of population aging, edentulism has become a prevalent oral health concern among older adults, affecting over 353 million people worldwide [1,2]. It impairs mastication, phonetics, and facial esthetics; it may lead to nutritional deficiencies and psychological distress, thereby greatly affecting oral health-related quality of life [2]. Current treatment strategies for edentulous patients (eg, conventional complete dentures, implant overdentures, and full-arch implant-supported prostheses) each have limitations related to retention, cost, or surgical complexity, especially in patients with systemic conditions or severe bone loss. The development of cost-effective and minimally invasive solutions remains a major challenge in edentulous rehabilitation.

The implant-crown-retained removable partial denture (ICRPD) is an evolving treatment modality that combines the benefits of implant-supported fixed prostheses and removable dentures. In ICRPDs, additional support and retention are provided for removable prostheses through a small number of implant-supported splinted crowns or pontics in the edentulous area [3,4]. Although promising results, including improved prosthesis stability and chewing function, have been achieved in partially edentulous patients [3-9], attempts to apply ICRPDs in fully edentulous cases have mostly relied on cross-arch splinted designs (eg, #14-#24) [3-5], which may increase stress concentration and mechanical complications. Limited research has addressed ICRPD designs using short-span splinted implant crowns that do not cross the midline, such as segmented crown units. The clinical performance, biomechanical behavior, and clasp design of these alternative configurations warrant thorough investigation.

This case report describes an incremental design refinement of the ICRPD for maxillary edentulous rehabilitation, specifically a non-cross-arch configuration with segmented short-span splinted crowns and occlusal-rest-free ring clasps. Four implants were placed in the bilateral canine and first premolar regions and restored with short-span splinted crowns that did not cross the midline. Ring clasps without occlusal rests directly engaged the retentive undercut areas of the implant crowns, a design intended to reduce unfavorable stress transmission to the implants. Rather than introducing a new treatment modality, the present report documents the clinical feasibility of this specific design over 4 years in a patient with maxillary edentulism, including prosthesis retention, the presence or absence of biological and mechanical complications, patient-reported satisfaction, and radiographic bone stability. The biomechanical rationale for this design is presented as a hypothesis-generating framework to contextualize the observed clinical findings.

Case Report

Patient Information

A 61-year-old man presented with a 3-month history of missing maxillary left posterior teeth, accompanied by reduced masticatory efficiency and mobility of the maxillary right anterior teeth. He was dissatisfied with the retention of his previous removable partial denture (RPD). The patient had worn an RPD for 2 years, with progressively deteriorating retention. He had no history of systemic disease, infection, drug allergies, or previous implant therapy. He had smoked 10 cigarettes per day for 20 years.

Clinical Findings

Intraoral examination revealed a partially edentulous maxilla with missing posterior teeth bilaterally, corresponding to a Kennedy Class I arch classification. Tooth #13 showed Grade II mobility, and tooth #14 exhibited Grade III mobility, both with probing depths of approximately 8 mm. Tooth #23 remained as a root fragment. Generalized gingival erythema, edema, and bleeding on probing were observed; periodontal probing depths ranged from 6 to 8 mm across the maxillary arch. Visible plaque and calculus accumulation were present.

Cone-beam computed tomography (CBCT) (NewTom, Italy) demonstrated adequate bone volume in the anterior maxilla (Table 1), whereas the posterior regions (#16, #17, #26, and #27) showed insufficient vertical bone height for conventional

Table 1. Cone-beam computed tomography analysis of proposed implant sites.

Tooth position	Bone height (mm)	Bone width (mm)	Degree of bone resorption
#13	21.1	7.2	Middle half of the root
#14	14.6	8.7	Middle half of the root
#23	18.8	7.4	Apical third, with a periapical radiolucency
#24	9.7	5.7	Not applicable

Note: Tooth #24 was absent, so bone loss relative to root length could not be assessed.

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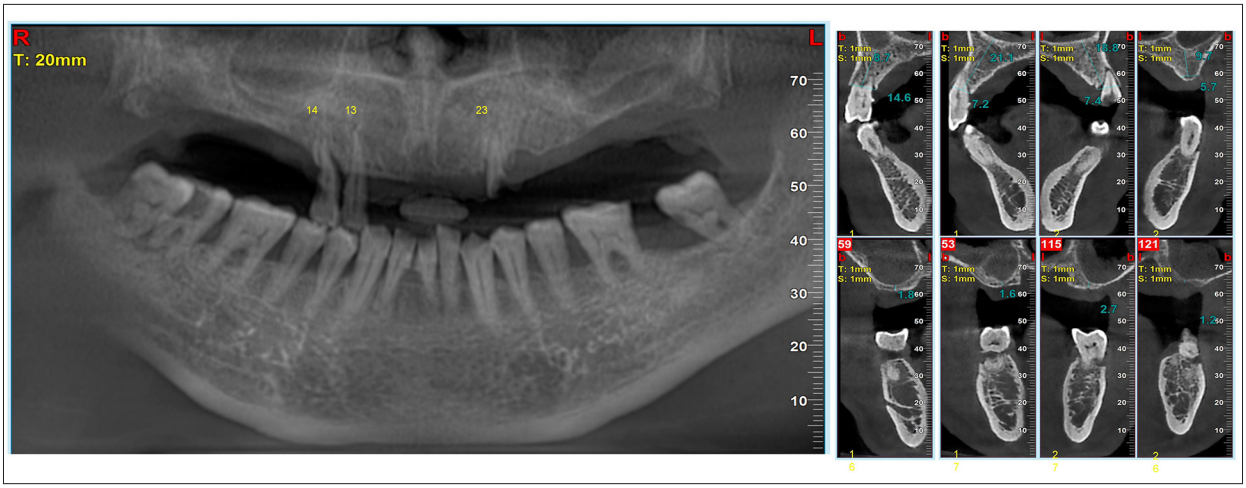


Figure 1. Preoperative cone-beam computed tomography evaluation. Panoramic and cross-sectional views of regions #13, #14, #23, #24, #16, #17, #26, and #27 were used to measure bone height and width, then assess the feasibility of implant placement.

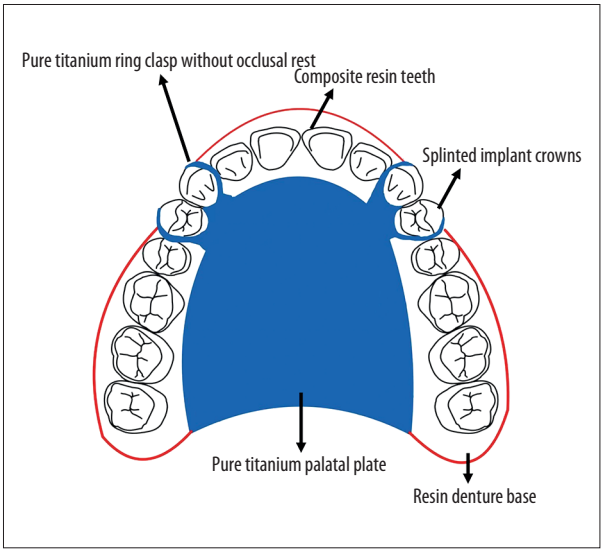


Figure 2. Basic design of the implant-crown-retained removable partial denture (ICRPD). The ICRPD incorporated 2 short-span splinted crown units fabricated for sites #13-#14 and #23-#24. Pure titanium ring clasps without occlusal rests served as direct retainers.

implant placement. Sites #13, #14, #23, and #24 were identified as suitable for implant placement (**Figure 1**).

Diagnostic Assessment

The patient was diagnosed with maxillary partial edentulism and chronic periodontitis.

Treatment Plan

Initial periodontal therapy was performed. Teeth #13, #14, and #23 were extracted; implants were placed at sites #13, #14, #23, and #24. After tissue healing, second-stage surgery and impressions were completed. Given the inadequate posterior bone height, the patient's preference for minimally invasive treatment, and his previous dissatisfaction with the retention of a conventional RPD, an ICRPD was selected (**Figure 2**). An attachment-retained implant overdenture was considered a relevant alternative; however, the selected 4-crown, clasp-retained ICRPD eliminated the need for additional attachment components while providing implant-supported retention. The treatment decision was primarily based on patient-specific clinical findings and treatment preferences. The anticipated esthetic and cost-effectiveness advantages of this design were not directly evaluated or established in this single case. The implant crowns provided primary retention without occlusal rests.

Prosthetic Modality

The final prosthetic design was an ICRPD (**Figure 2**). Its key structural features are summarized below.

Implant Crown Design

Short-span splinted crowns were fabricated on implants at sites #13 to #14 and #23 to #24 to serve as abutments. Compared with cross-arch splinted designs frequently reported in the literature [3-5], this design avoids long-span bridges. This feature is hypothesized to reduce stress concentration and occlusal loads that could contribute to implant failure.

Clasp Design

Ring clasps without occlusal rests were used to directly engage retentive undercuts on the implant crowns. Previous studies have shown that removing occlusal rests alters denture-base pressure distribution [10] and that clasp configuration

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Figure 3. Postoperative implant placement and clinical outcomes. (**A**) Postoperative cone-beam computed tomography scan showing implants placed at sites #13, #14, #23, and #24. (**B**) Periapical radiographs obtained at second-stage surgery showing well-positioned implants with clearly defined crestal bone margins at sites #13, #14, #23, and #24. (**C**) Intraoral view after placement of the implant crowns. (**D**) Intraoral view of the implant-crown-retained removable partial denture (ICRPD) in place. (**E**) Frontal view showing occlusion with the ICRPD in place.

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Table 2. Treatment timeline.

Time from initial treatment	Treatment procedures
Day 0	Extraction of teeth #13, #14, and #23 Placement of 4 Osstem implants (4.2 × 10 mm) at sites #13, #14, #23, and #24 Placement of cover screws Postoperative cone-beam computed tomography confirmation of proper implant positioning Routine administration of antibiotics and analgesics, with regular follow-up
Month 5.5	Second-stage surgery: exposure of 4 maxillary implants Removal of cover screws and placement of healing abutments
Month 6	Final implant impressions using open-tray technique Recording of maxillomandibular relationship
Month 7	Fabrication and delivery of 4 implant-supported crowns Completion of implant-crown-retained removable partial denture Occlusal adjustment to ensure proper function and fit

Note: Time points are approximate, based on the date of initial treatment (Day 0).

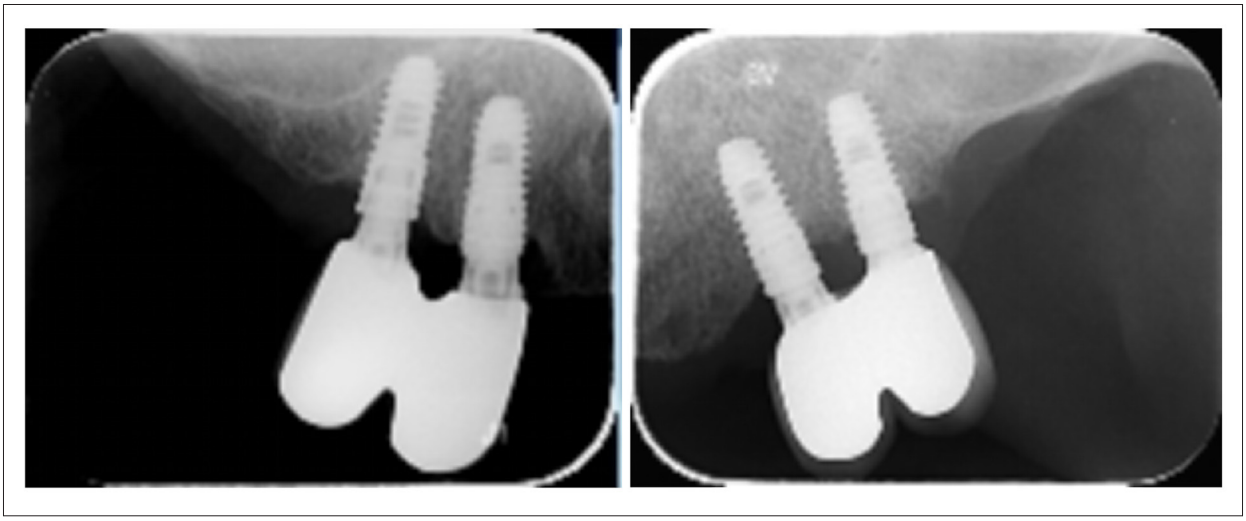


Figure 4. Periapical radiographs at the 4-year follow-up. Periapical images of implants at sites #13, #14, #23, and #24 demonstrate stable marginal bone levels consistent with Albrektsson's criteria for implant success.

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influences peri-implant stress in implant-assisted RPDs [11]. These findings informed the present design, which was intended to reduce unfavorable leverage associated with rest-mediated loading while maintaining clasp retention. The resulting modification of load transfer may help limit implant overload and loosening.

Implant Placement Sites

Implants were placed in the bilateral canine and first premolar regions (#13-#14 and #23-#24), where bone quality is generally superior due to a higher proportion of cortical bone and greater buccopalatal bone volume. These locations avoid the posterior maxillary sinus region where vertical bone height is insufficient, thereby eliminating the need for advanced bone grafting procedures. The favorable morphology and bone density at the selected implant sites support improved primary stability and long-term implant survival [12,13] while facilitating functional occlusion and esthetic integration.

Treatment Course

Approximately 6 months after initial presentation, tooth extractions and implant placement were performed under local anesthesia. Four Osstem implants (TSIII SA, 4.2 × 10 mm, South Korea) were placed at sites #13, #14, #23, and #24 with an insertion torque of 35 N·cm. Postoperative CBCT confirmed proper implant positioning (**Figure 3A**). Approximately 5.5 months later, second-stage surgery was completed, and periapical radiographs showed well-defined bone margins (**Figure 3B**). After 2 additional weeks of healing, open-tray impressions and bite registration were performed. One month

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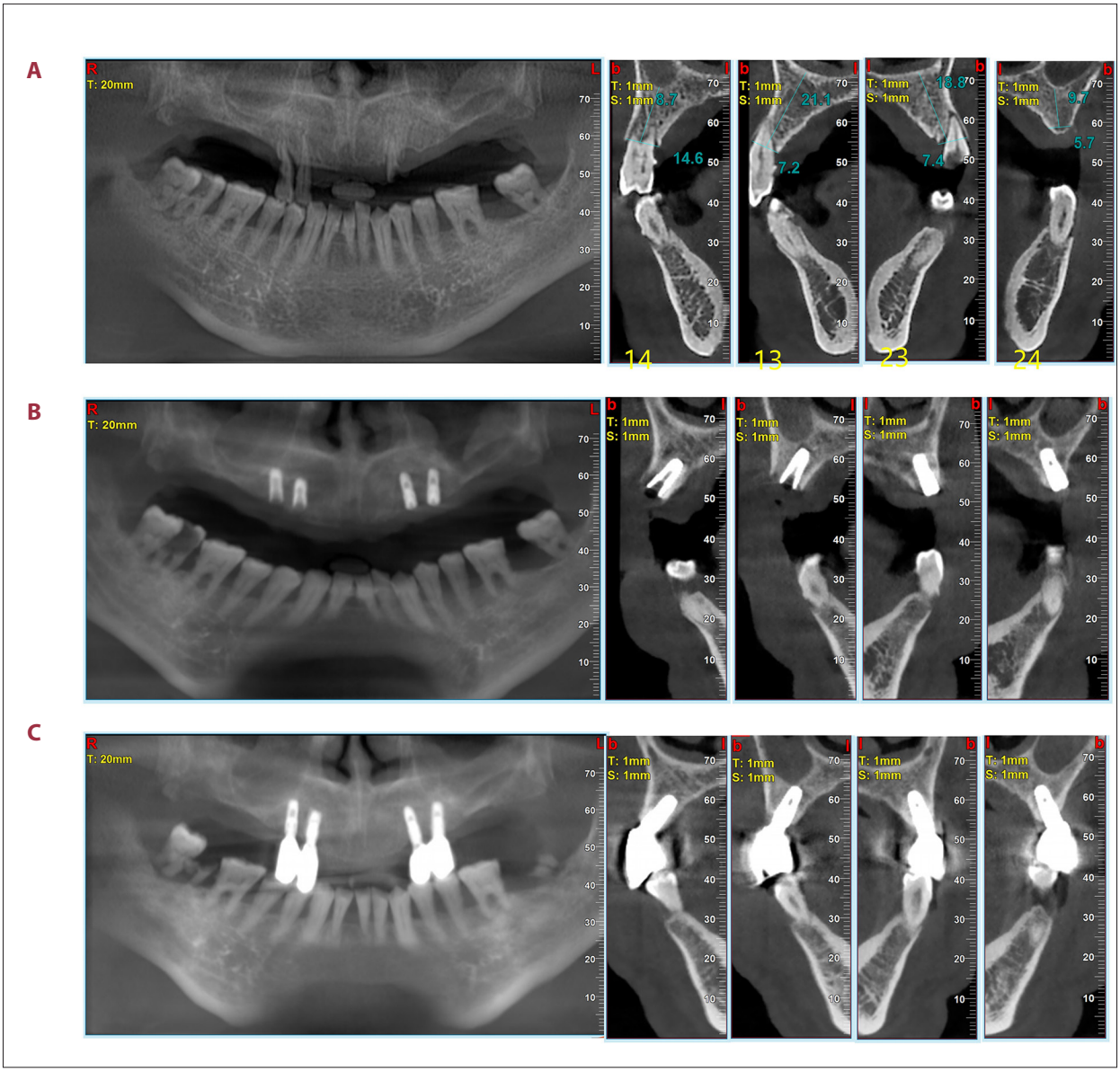


Figure 5. Cone-beam computed tomography (CBCT)-based assessment of bone changes over time. (**A**) Preoperative panoramic and cross-sectional CBCT images showing the initial bone volume. (**B**) Postoperative CBCT images obtained after implant placement. (**C**) CBCT images obtained 4 years after prosthesis delivery, demonstrating maintenance of stable bone volume.

later, the final ICRPD, incorporating 2 short-span splinted units and ring clasps without occlusal rests, was delivered. Occlusion was adjusted (**Figure 3C-3E**). The treatment timeline is summarized in **Table 2**.

Follow-up and Outcomes

At the 4-year follow-up, probing depths ranged from 1 to 3 mm; no bleeding on probing was evident. Marginal bone loss (MBL), measured on periapical radiographs using a previously reported method [3], was 1.67 mm (#13), 1.23 mm (#14), 0.16 mm (#23), and 0.94 mm (#24), all within Albrektsson's success criteria (**Figure 4**) [14]. CBCT showed stable marginal bone levels (**Figure 5**). The prosthesis adapted well to the soft tissues, without tenderness or ulceration (**Figure 6**).

The total score on the Chinese version of the Oral Health Impact Profile for Edentulous Subjects (OHIP-EDENT) [15] decreased from 5 to 2 (**Table 3**). Pain intensity was assessed using a visual analog scale ranging from 0 (no pain) to 10 (extreme pain); higher scores indicated greater pain intensity. The visual analog scale pain score decreased from 3 to 0 at the 4-year follow-up, indicating resolution of the reported pain. The patient reported high satisfaction with the prosthesis. **Figure 7** compares

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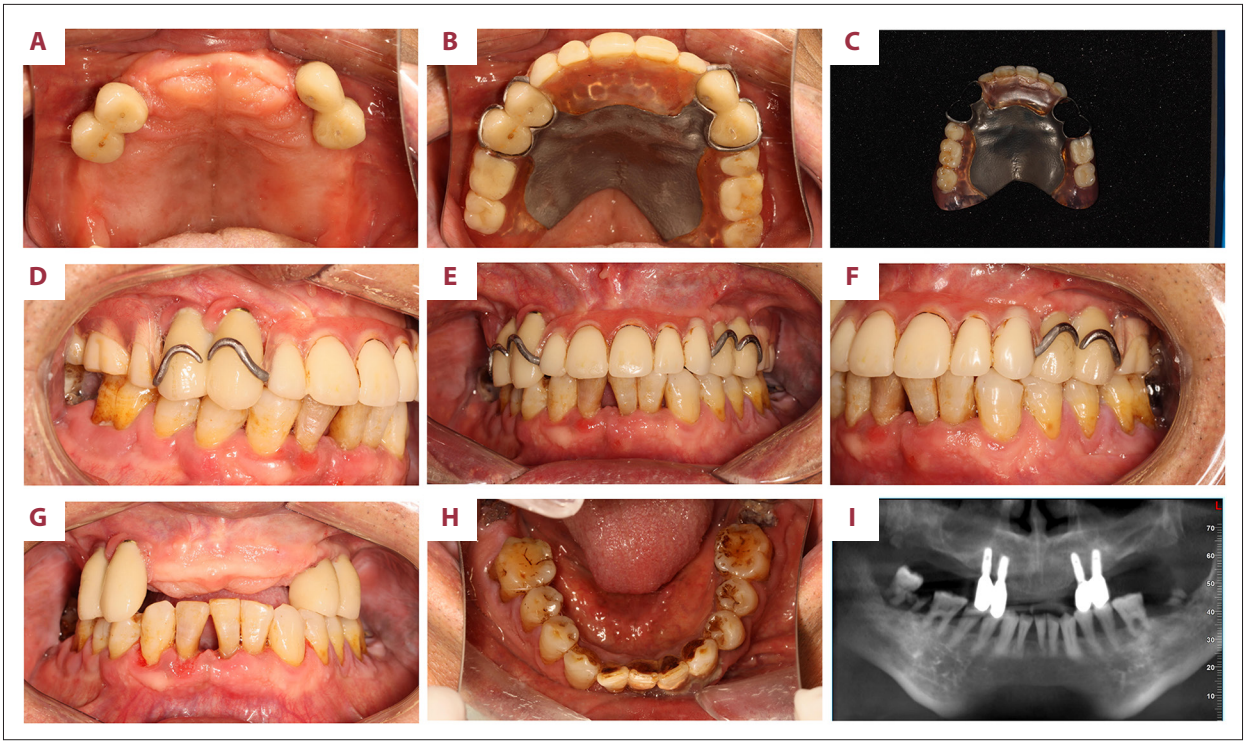


Figure 6. Clinical photographs and panoramic radiograph at the 4-year follow-up. (**A**) Maxillary arch without the prosthesis. (**B**) Maxillary arch with the implant-crown-retained removable partial denture (ICRPD) in place. (**C**) The ICRPD. (**D-F**) Intraoral views of the ICRPD in place from the right, frontal, and left perspectives. (**G**) Frontal intraoral view without the prosthesis. (**H**) Intraoral view of the mandibular arch. (**I**) Panoramic radiograph at the 4-year follow-up.

the prosthesis at initial insertion and at the 4-year follow-up. The postoperative panoramic radiograph (**Figure 7A**) and intraoral views at initial insertion (**Figure 7B-7D**) and the corresponding images at 4 years (**Figure 7E-7H**) demonstrate stable prosthesis adaptation, preservation of the maxillary arch contour, and no visible prosthetic complications, corroborating the clinical and radiographic findings described above. The patient brushed once daily using a horizontal brushing technique. No clasp loosening or framework fractures occurred, and no relining was required. Only mild occlusal wear was observed.

Discussion

As an evolving treatment modality combining fixed and removable prostheses, ICRPDs have demonstrated distinct value in edentulous rehabilitation [3-5,7,8,16]. The present case represents a refinement of the ICRPD design through the incorporation of segmented short-span splinted crowns and an occlusal-rest-free ring clasp configuration for the management of a patient with maxillary edentulism. Direct observations at 4 years included (1) stable prosthesis retention without dislodgement, (2) absence of biological or mechanical complications, (3) MBL within Albrektsson's success criteria, and (4) high patient-reported satisfaction. Such favorable clinical findings support the feasibility of this design in the present case.

Occlusal rest and clasp configurations influence load transfer in removable partial dentures. In an in vivo study of a tooth-retained RPD, Kubo et al found that reducing the number of occlusal rests altered pressure distribution and increased loading of the residual ridge [10]. Rungsiyakull et al demonstrated that different clasp designs produced distinct peri-implant stress patterns in mandibular mini-implant-assisted RPDs [11]. Collectively, these findings provide a rationale for exploring modifications to rest and clasp configurations to improve load distribution. The present design refinement differs from previously reported ICRPD configurations by combining occlusal-rest-free ring clasps with segmented short-span splinted crowns in a patient with maxillary edentulism. To optimize load distribution, ring clasps without occlusal rests were used to directly engage undercuts of the implant crowns for retention (**Figure 2**). By omitting rest-mediated contact with the implant crowns, this configuration was intended to modify load sharing between the implants and supporting mucosa, potentially reducing unfavorable leverage and stress concentration at the implant necks. Unlike previous reports of crown dislodgement, clasp loosening, or fracture [3-5,7,8,16,17], no such complications occurred in the present case. In conjunction with stable

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Table 3. Comparison of Oral Health Impact Profile for Edentulous Subjects scores (Chinese version) at initial insertion and the 4-year follow-up.

Item	At initial insertion	At 4-year follow-up
Functional limitation		
Chewing difficulty	0	0
Food getting caught	0	1
Poor denture fit	0	0
Physical pain		
Painful aching	0	0
Discomfort while eating	1	0
Sore spots	0	0
Denture discomfort	1	0
Psychological discomfort		
Feeling worried	0	0
Feeling self-conscious	0	0
Physical disability		
Avoiding eating	0	0
Inability to eat	0	0
Interrupted meals	1	1
Psychological disability		
Feeling upset	0	0
Feeling embarrassed	1	0
Social disability		
Reduced tolerance of others	0	0
Irritability toward others	1	0
Avoiding going out	0	0
Handicap		
Inability to enjoy the company of others	0	0
Dissatisfaction with life	0	0

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prosthesis retention over 4 years, these findings provide encouraging clinical support for the combined design and are consistent with its anticipated biomechanical advantages. However, the absence of occlusal rests may allow greater occlusocervical prosthesis displacement under functional loading relative to rest-supported designs, representing a potential limitation of this configuration. Neither the proposed stress-reduction benefit nor the possible increase in prosthesis movement was directly measured in the present case. These potential biomechanical trade-offs therefore remain hypothetical and require evaluation in comparative biomechanical studies.

Most previous ICRPD studies have adopted long-span cross-arch splinted designs (eg, #14-#24 bridges) [3-5], which may increase stress concentration and the risk of implant overload [18,19]. The present case illustrates the feasibility of applying a segmented short-span splinted design in a patient with maxillary edentulism, extending previous ICRPD reports that primarily adopted cross-arch splinted restorations. Each unit comprised 2 adjacent implants, establishing separate retentive foundations. This configuration is hypothesized to mitigate distal cantilever forces and potentially reduce cross-arch stress concentration while facilitating unit-specific maintenance. Compared with the 42.8% clasp loosening rate reported in maxillary Kennedy Class I ICRPDs [5], no such complications were observed in the present case, consistent with the hypothesis of improved biomechanical control with this design. However, because no direct comparison was performed in the present report, this interpretation remains speculative and requires confirmation in future comparative studies.

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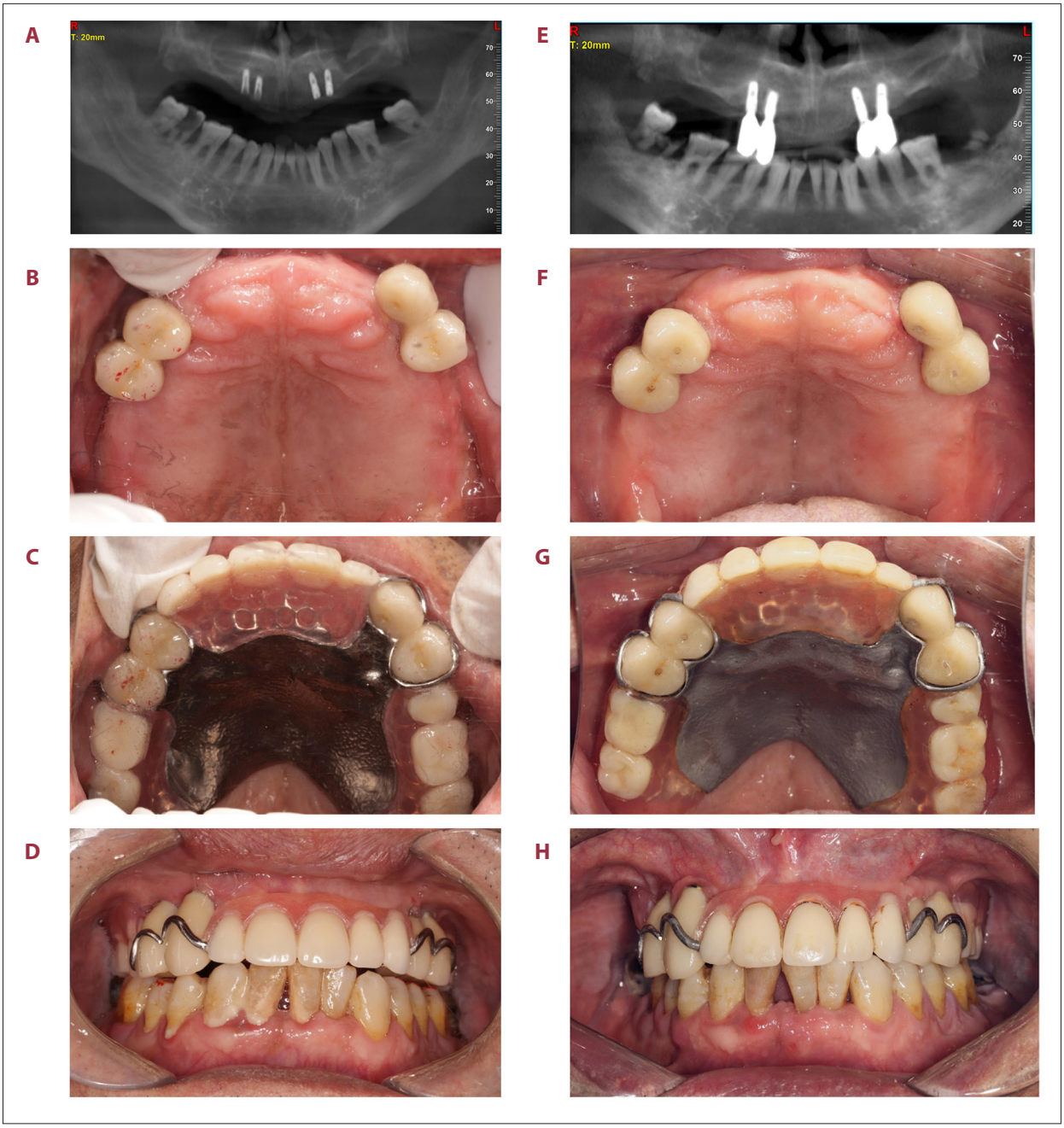


Figure 7. Comparison of prosthesis status at initial insertion and the 4-year follow-up. (**A**) Postoperative panoramic radiograph following implant placement. (**B, C**) Intraoral photographs showing the maxillary edentulous ridge before and after denture insertion. (**D**) Frontal view of the maxillary arch with the implant-crown-retained removable partial denture (ICRPD) in place at initial insertion. (**E**) Panoramic radiograph at the 4-year follow-up. (**F, G**) Intraoral views of the edentulous maxilla without and with the prosthesis in place at 4 years. (**H**) Frontal intraoral view with the ICRPD in place at the 4-year follow-up.

Implant site selection for edentulous rehabilitation requires balancing biomechanics, surgical feasibility, and cost. Maxillary posterior sites often require sinus augmentation [3,20,21], whereas the premolar region offers greater bone height and cortical support, enabling implant placement with less augmentation [22]. Anterior positioning of implants in the premolar region has been reported to optimize stress distribution and improve denture stability [3,21,22], consistent with clinical observations in the present case. Implants placed bilaterally in the canine and first premolar regions provided a symmetrical support pattern, avoided the need for bone grafting, and improved prosthesis stability and patient satisfaction.

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Compared with conventional complete dentures, implant overdentures, and full-arch implant-supported prostheses, ICRPDs may offer a minimally invasive and cost-effective alternative. Conventional complete dentures often lack retention and stability [23]. Implant overdentures require regular attachment replacement, increasing maintenance costs [24], although attachment-retained designs may provide superior retention and greater perceived stability. Full-arch fixed prostheses require favorable bone conditions, extensive surgery, and high costs [25]. The present design achieved full-arch rehabilitation with only 4 implants, using combined implant-mucosal support to enhance retention and comfort [26] while potentially reducing residual ridge resorption [3]. Additionally, the absence of attachment components simplifies maintenance compared with implant overdentures [27]. However, these potential advantages are based on the design rationale, rather than direct comparative evidence from the present case. Because this single case lacked a control group for comparison, the favorable outcomes should be interpreted as supporting the clinical feasibility of this design in a single patient, rather than demonstrating its general superiority over attachment-retained alternatives in terms of esthetics, cost-effectiveness, or overall treatment success. Building on the McGill and York consensus statements that 2 implants can achieve functional rehabilitation [28,29], the present treatment approach utilized a bilaterally symmetrical configuration to optimize stability.

Retrospective studies have reported ICRPD implant survival rates of 97.3% to 98.3% and MBL of approximately 0.93 to 1.12 mm [6]. Periapical radiographic assessment at the 4-year follow-up in the present case confirmed that MBL remained within Albrektsson's success criteria [14]. The segmented short-span crowns are hypothesized to reduce stress and simplify maintenance compared with cross-arch splinted designs, although this hypothesis was not directly tested. Kim et al [6] reported lower implant failure rates with ICRPDs than with implant overdentures; however, mechanical complications such as crown dislodgement and clasp loosening are common in conventional designs. The patient in the present case experienced no mechanical complications over 4 years, an observation consistent with the anticipated biomechanical behavior of occlusal-rest-free ring clasps and short-span splinted crowns.

This report describes a single case; although 4-year follow-up data are presented, the influence of individual variability on the outcomes cannot be excluded. The absence of annual CBCT imaging limits longitudinal assessment of 3-dimensional changes in bone. Additionally, because the case records did not include biomechanical testing or modeling (eg, strain gauges or finite element analysis) and no comparative control group was involved, the biomechanical interpretations remain hypothetical rather than conclusively demonstrated. Future studies should incorporate occlusal force sensors and comparative designs to clarify how ring clasps without occlusal rests transmit forces, thus testing the biomechanical hypotheses generated by this case report.

Conclusions

This 4-year follow-up case report documents the successful use of the described ICRPD design, featuring occlusal-rest-free ring clasps and short-span splinted crowns, in a patient with maxillary edentulism. At the 4-year follow-up, stable prosthesis retention, favorable MBL values (0.16-1.67 mm), no biological or mechanical complications, and high patient satisfaction were observed. These findings support the clinical feasibility of this specific design refinement in a single patient, but the proposed biomechanical benefits remain hypothetical and require further validation.

Department and Institution Where Work Was Done

The 920th Hospital of Joint Logistics Support Force, PLA, Kunming, Yunnan, PR China.

Patient Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images.

Declaration of Figures' Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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