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# Rehabilitation of Partially Edentulous Mandibular Arch with CAD/CAM Fabricated Semi-Precision Attachment and Cast Partial Denture: A Case Report

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## Abstract

Rehabilitation of partially edentulous arches poses challenges in achieving optimal function, retention, stability, and esthetics, particularly in Kennedy Class I and II situations with anterior standing teeth. Semi-precision attachments offer an alternative to conventional clasp-retained removable partial dentures by providing superior esthetics, improved retention, and better stress distribution. This case report describes the prosthodontic rehabilitation of a 56-year-old female patient with a completely edentulous maxillary arch and Kennedy Class I partially edentulous mandibular arch. The treatment involved fabrication of a conventional complete denture for the maxilla and a CAD/CAM designed and fabricated semi-precision ball attachment-retained cast partial denture for the mandible. The digital workflow incorporated scanning, digital design using Exocad software, and DMLS (Direct Metal Laser Sintering) fabrication of the metal framework with integrated ball attachments on the abutment teeth. The definitive prostheses provided excellent retention, stability, function, and esthetics. This case demonstrates the advantages of integrating digital dentistry techniques

with semi-precision attachments for rehabilitation of partially edentulous arches.

**Keywords**: Semi-Precision Attachment, Ball Attachment, CAD/CAM, Cast Partial Denture, Kennedy Class I, Digital Workflow, DMLS, Removable Partial Denture, Complete Denture.

**Introduction**

Prosthodontic rehabilitation of partially edentulous patients requires careful consideration of multiple factors including remaining tooth structure, periodontal health, occlusal forces, patient expectations, and esthetic demands. Removable partial dentures (RPDs) remain a viable and cost-effective treatment option for replacing missing teeth, particularly in situations where implant placement is contraindicated or economically not feasible[1,2].

Conventional clasp-retained RPDs, while functional, often present esthetic compromises due to visible metal clasps, especially in the anterior region. This has led to the development and use of precision and semi-precision attachments as alternatives to conventional clasps[3,4]. Attachments are mechanical devices used for fixation, retention, and stabilization of prostheses, consisting of two or more components. Precision attachments are manufactured with close tolerances, while semi-precision attachments allow for slight dimensional variations.

Ball attachments are among the most commonly used semi-precision attachments in removable prosthodontics due to their simplicity, ease of maintenance, and cost-effectiveness[5,6]. These attachments consist of a male component (ball or stud) attached to the abutment tooth or implant, and a female component (matrix) incorporated into the denture base. The resilient matrix material allows for some vertical and rotational movement, which can be beneficial in stress distribution.

The advent of digital dentistry has revolutionized prosthodontic treatment planning and execution. Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM) technology enables precise design and fabrication of dental prostheses with improved accuracy, reduced chairside time, and enhanced patient comfort[7,8]. Digital workflows incorporating intraoral scanning, digital design software, and additive or subtractive manufacturing techniques have been successfully applied to fabrication of RPD frameworks.

Direct Metal Laser Sintering (DMLS) is an additive manufacturing technology that produces metal frameworks by selectively fusing metal powder particles layer by layer using a high-powered laser. This technique offers advantages including elimination of casting defects, superior fit accuracy, design flexibility, and the ability to create complex geometries[9,10]. Integration of DMLS with digital design allows for precise positioning of attachment components and optimal framework design.

This case report presents the prosthodontic rehabilitation of a partially edentulous patient using a digitally designed and fabricated semi-precision ball attachment-retained cast partial denture for the mandibular arch and a conventional complete denture for the maxillary arch, demonstrating the clinical applications and benefits of combining digital technologies with semi-precision attachments.

**Case Report**: **Chief Complaint**

A 56-year-old female patient, Mrs. Suganthi, presented to the Department of Prosthodontics and Crown and Bridge with the chief complaint of difficulty in chewing food due to multiple missing upper and lower teeth and desired replacement of the missing teeth.

**Medical History**

The patient reported no relevant medical history. She was systemically healthy with no contraindications for dental treatment.

**Dental History**

The patient had lost her upper and lower teeth progressively over the past year due to mobility secondary to periodontal disease and dental caries. She had not received any prior prosthodontic treatment.

**Clinical Examination**

Extraoral examination revealed no significant facial asymmetry, adequate lip support was lost, and there was a decreased vertical dimension of occlusion. Temporomandibular joint examination was within normal limits with no signs of pain, clicking, crepitus or restricted mouth opening.

Intraoral examination revealed

- Maxillary arch: Completely edentulous with well-formed residual ridge, adequate sulcus depth, and healthy mucosa
- Mandibular arch: Partially edentulous with clinically missing teeth 48, 47, 46, 45, 44, 34, 35, 36, 37, 38 (Kennedy Class I)
- Remaining mandibular teeth: 43, 42, 41, 31, 32, 33 present with adequate crown height, moderate periodontal support, and mild attrition
- Oral hygiene: Fair
- Mucosa: Healthy, firm, and adequate in thickness

Figure 1: Intra-oral – frontal view

Figure 2.1: Extra – oral Facial

Figure 2.2: Extra – oral Profile view

**Diagnosis**

Based on clinical and radiographic findings, the patient was diagnosed with:

- Kennedy Class II completely edentulous maxillary arch (ACP Classification)
- Kennedy Class I partially edentulous mandibular arch (ACP Classification)

**Treatment Plan**

A comprehensive treatment plan was formulated:

Phase I: Pre-prosthetic Phase

1. Oral prophylaxis and oral hygiene instructions

Phase II: Prosthodontic Rehabilitation

1. Conventional complete denture for maxillary arch
2. CAD/CAM designed semi-precision ball attachment-retained cast partial denture for mandibular arch

- Ball attachments on teeth 43 and 33 (canines)
- Cast metal framework fabricated using DMLS technology

- Acrylic denture base with artificial teeth

Phase III: Maintenance Phase

- Post-insertion adjustments
- Regular recall and maintenance appointments
- Oral hygiene reinforcement
- Periodic replacement of matrix attachments

**Clinical Procedures**

Maxillary Complete Denture Fabrication

1. Preliminary Impressions - Preliminary impressions of both arches were made using irreversible hydrocolloid (alginate) material in stock trays. The impressions were poured in dental stone to obtain primary casts.

Figure 3: Preliminary impression

2. Mandibular Preliminary Impression and Surveying After preliminary impression and primary cast fabrication, the mandibular cast was surveyed to determine the path of insertion and identify undercuts. The canine teeth (43 and 33) were selected as abutments for ball attachments based on their favorable crown-to-root ratio, adequate bone support, and strategic location.

3. Tooth Preparation - The mandibular anterior teeth were prepared to receive ball attachments

Figure 4: Tooth preparation

3. Border Molding and Final Impression Border molding of the maxillary custom tray was performed using low-fusing impression compound. The final impression was made using zinc oxide eugenol impression paste. The impression was poured in dental stone to obtain the master cast. Border molding of mandibular custom tray was done using low-fusing impression compound and final impression was made using light body addition silicone impression material.

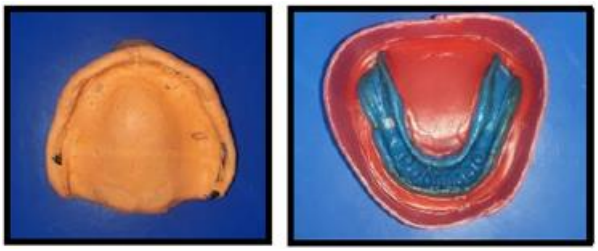

Figure 5: Final impression

4. Jaw Relation Records - Occlusal rims were fabricated on both maxillary and mandibular record bases

- Vertical dimension of occlusion was determined using physiologic rest position and phonetics
- Centric relation was recorded

Figure 6 – Jaw relation

5. Articulator Mounting

- Maxillary cast and Mandibular cast mounted using centric relation record

Figure 7: Articulator mounting

6. Digital Workflow

Digital impressions were captured using a lab scanner. The maxillary arch, mandibular arch, and bite registration were scanned to obtain digital files in STL format.

Digital Design - Exocad Software

The STL files were imported into Exocad dental CAD software for digital design:

- Framework design with optimal thickness
- Lingual bar major connector selected
- Ball attachment placement on prepared canines (43 and 33) with precise angulation
- Retention mesh areas designed for acrylic denture base attachment
- Anterior and posterior denture base areas defined
- Framework inspected for adequate thickness, smooth contours, and proper connector design

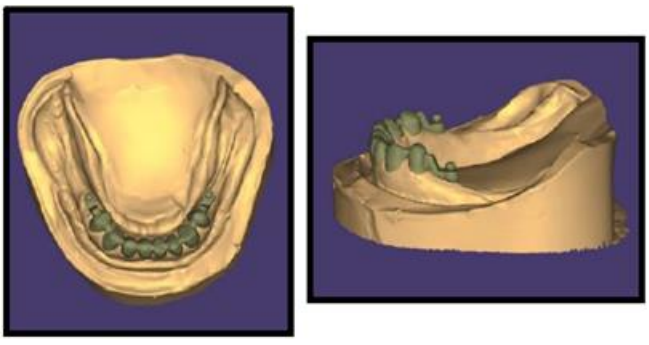

Figure 8: Designing of Rhein 83 ball attachment

Figure 9: Designing of cast partial denture framework with metal housing ball attachment

7. DMLS Fabrication of Metal Framework The digital design was exported as an STL file and sent for DMLS fabrication.

Figure 10: Completed Rhein 83 ball attachment and cast partial denture framework

8. Wax Try-In

Both prostheses were tried in the patient's mouth simultaneously:

- Verification of vertical dimension
- Centric relation verification
- Esthetic evaluation (teeth position, size, shade, lip support)
- Phonetics evaluation
- Patient approval obtained

Figure 11: Wax Try-In

9. Matrix Housing Incorporation during acrylization of cast partial denture

Figure 12: Completed prosthesis

Figure 13: Completed prosthesis

10. Denture Insertion Both dentures were inserted in the following sequence:

- Maxillary complete denture inserted first
- Mandibular partial denture with semi-precision attachments inserted
- Retention and stability verified
- Patient educated on insertion, removal, and maintenance
- Home care instructions provided

Figure 14: Denture insertion

Figure 15: Pre and post operative – frontal view

11. Post-Insertion Care

- Patient recalled after 24 hours for first adjustment
- Subsequent recalls at 1 week, 1 month, and 3 months
- Minor occlusal adjustments performed as needed
- Oral hygiene reinforcement
- Matrix replacement scheduled as needed (typically 12-18 months)

**Treatment Outcome**

The patient was successfully rehabilitated with maxillary complete denture and mandibular semi-precision attachment-retained cast partial denture. At 6-month follow-up:

- Excellent retention and stability of both prostheses
- Improved masticatory efficiency reported by patient
- Superior esthetics with no visible clasps
- Enhanced patient confidence and satisfaction
- Good oral hygiene maintenance
- Healthy supporting tissues
- No pain or discomfort
- Ball attachments functioning optimally

**Discussion**

This case report demonstrates successful rehabilitation of a partially edentulous patient using a combination of conventional prosthodontic principles and modern digital dentistry techniques. The integration of CAD/CAM technology with semi-precision attachments offers multiple advantages over traditional clasp-retained removable partial dentures.

**Rationale for Semi-Precision Attachments**

Semi-precision ball attachments were selected for this case based on several clinical considerations. In Kennedy Class I situations with anterior standing teeth, conventional clasp-retained RPDs often display metal clasps in the esthetic zone, which is cosmetically unacceptable to many patients. Ball attachments eliminate this concern by incorporating the retentive mechanism within the denture base, providing superior esthetics.

The biomechanical advantages of ball attachments include improved stress distribution compared to rigid clasp retention. The resilient matrix material allows for controlled micromovement during function, which can reduce stress concentration on abutment teeth. Studies have demonstrated that attachment-retained RPDs distribute occlusal forces more favorably than clasp-retained designs, potentially improving the longevity of abutment teeth.

The choice of canines as abutments was strategic, as these teeth typically have favorable crown-to-root ratios, adequate bone support, and are positioned to provide anterior retention while minimizing torque forces. The bilateral placement of attachments ensures balanced retention and stability while preventing rotational movement of the prosthesis.

**Digital Workflow Advantages**

The incorporation of digital technologies transformed the traditional RPD fabrication process. CAD/CAM design using Exocad software offered several benefits:

1. Precise visualization: Three-dimensional visualization of the framework design allowed for optimization before fabrication
2. Accurate attachment positioning: Digital planning ensured ideal angulation and placement of ball attachments
3. Framework optimization: Thickness, contours, and connector design could be refined digitally
4. Predictable outcomes: Virtual design reduces trial-and-error of traditional wax-up methods
5. Documentation: Digital files serve as permanent records[9,10]

**DMLS Technology for Framework Fabrication**

Direct Metal Laser Sintering offered advantages over conventional lost-wax casting:

1. Superior fit accuracy: Studies report better marginal adaptation with DMLS compared to cast frameworks
2. Elimination of casting defects: Porosity, distortion, and investment inclusions are eliminated
3. Material properties: Homogeneous structure with consistent mechanical properties
4. Design flexibility: Complex geometries and integrated attachments possible
5. Time efficiency: Reduces laboratory steps and chair time

The integration of ball attachments directly into the DMLS framework eliminated the need for soldering separate attachment components, reducing potential weak points and improving accuracy.

**Clinical Outcomes and Maintenance**

Semi-precision attachments require patient education and periodic maintenance. The resilient matrix components (nylon caps) wear over time and require replacement, typically every 12-18 months depending on usage and oral hygiene. This is a minor disadvantage compared to clasp retention, which may require periodic clasp adjustment but less frequent component replacement.

Proper oral hygiene is critical for long-term success. Patients must be instructed to remove the prosthesis for cleaning and to clean the ball attachments on the abutment teeth thoroughly. Accumulation of plaque and

debris around attachment components can lead to caries, periodontal disease, and premature attachment failure.

**Alternative Treatment Options**

Alternative treatment approaches for this clinical situation include:

1. Conventional clasp-retained RPD: Lower cost but compromised esthetics
2. Implant-supported overdenture: Superior retention but higher cost and surgical requirements
3. Implant-supported fixed prosthesis: Optimal stability but significantly higher cost
4. Telescopic crown-retained RPD: Excellent retention but requires extensive tooth preparation

The semi-precision attachment approach offered an optimal balance of esthetics, function, retention, and cost-effectiveness for this patient.

**Conclusions**

This case report demonstrates that rehabilitation of partially edentulous arches using CAD/CAM fabricated semi-precision ball attachment-retained cast partial dentures is a viable and effective treatment option. The integration of digital technologies including intraoral scanning, CAD design, and DMLS fabrication enhances accuracy, efficiency, and predictability compared to conventional methods. Semi-precision attachments provide superior esthetics and favorable biomechanics compared to clasp retention. This approach represents the successful fusion of traditional prosthodontic principles with modern digital dentistry, resulting in functional, esthetic, and patient-satisfying outcomes. Regular maintenance and patient compliance are essential for long-term success.

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**Abbreviations**

| Abbreviation | Full Form |
|---|---|
| **RPD** | Removable Partial Denture |
| **CAD/CAM** | Computer-Aided Design / Computer-Aided Manufacturing |
| **DMLS** | Direct Metal Laser Sintering |
| **OPG** | Orthopantomogram |
| **STL** | Stereolithography (digital file format) |
| **ACP** | American College of Prosthodontists |