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Prosthodontic Rehabilitation of a Kennedy's Class I Edentulous Arch: Integration of Altered Cast Technique and CAD-Assisted Cast Partial Denture Fabrication: A CASE REPORT

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ABSTRACT
The rehabilitation of Kennedy's Class I partially edentulous cases presents unique biomechanical challenges due to the combined reliance on tooth and tissue support. Cast partial dentures (CPDs) offer a viable alternative to implant-supported prostheses, particularly when implants are contraindicated due to systemic, anatomical, or financial limitations. This case report highlights the prosthodontic management of a patient with a completely edentulous maxillary arch and a partially edentulous mandibular arch (Kennedy's Class I, modification 1) using a combination of an anterior fixed partial denture (FPD) and a posterior CPD fabricated through computer-aided design (CAD) technology. The altered cast impression technique was employed to enhance the fit, stability, and functional adaptation of the CPD by accurately recording the edentulous ridge under functional conditions. Additionally, CAD-assisted framework fabrication ensured precision, improved adaptation, and optimized stress distribution. The final prosthesis successfully restored masticatory function, comfort, and patient satisfaction. This case underscores the significance of combining conventional prosthodontic principles with digital advancements to improve the predictability and efficiency of removable prosthesis fabrication.

Keywords: Cast partial denture, CAD/CAM, Kennedy's Class I, Altered Cast technique.

1. INTRODUCTION
The loss of teeth is a progressive and multifactorial phenomenon that frequently culminates in partial edentulism, adversely affecting mastication, phonetics, and facial esthetics. Prosthodontic rehabilitation of such patients is not merely a restorative endeavor but a comprehensive approach aimed at re-establishing oral function, preserving remaining oral structures, and enhancing overall quality of life. Among the various patterns of partial edentulism, Kennedy's Class I and Class II scenarios present unique biomechanical challenges due to their dual reliance on tooth and tissue support, often leading to compromised stability and retention of prosthetic devices[1].
According to the *Glossary of Prosthodontic Terms*, esthetics is defined as "pertaining to the study of beauty and the sense of the beautiful." Esthetics plays an equally pivotal role in prosthodontic rehabilitation as function. For partially edentulous patients, a prosthetic solution must closely emulate natural dentition in both appearance and utility to foster patient satisfaction and psychological well-being. Enhancing esthetics through appropriate prosthesis selection can significantly improve a patient's self-confidence and social interactions[2][3].
In distal extension cases, prosthetic management is primarily limited to two options: implant-supported fixed prostheses and removable dental prostheses. While implants offer high success rates and superior biomechanics, their adoption may be limited due to several factors including inadequate bone volume, systemic health contraindications, cost constraints, and patient reluctance towards surgical procedures[^3]. In such clinical situations, cast partial dentures (CPDs) emerge as a practical and conservative alternative, particularly for Kennedy's Class I and II cases. CPDs provide notable advantages

over acrylic-based prostheses in terms of masticatory efficiency, biomechanical durability, distortion resistance, and periodontal preservation[4][5].

CPDs require dual support from hard and soft tissues, making the precision of impression techniques paramount to success. Among these, the altered cast technique stands out as a gold standard in managing distal extension cases. This method captures the functional form of the edentulous ridge, resulting in improved denture base adaptation, reduced stress on abutment teeth, diminished food impaction, and better ridge preservation—all contributing to enhanced prosthesis stability, retention, and patient comfort[6].

Although conventional CPD fabrication involves multiple intricate and labor-intensive laboratory steps demanding significant manual skill, recent advances in digital technology have revolutionized prosthodontic workflows. The incorporation of computer-aided design and manufacturing (CAD/CAM) technologies enables the design and fabrication of RPD frameworks with increased accuracy and reproducibility while significantly reducing production time. These digital techniques fall into two broad categories: subtractive and additive manufacturing. Subtractive methods, such as CNC milling from metal blocks, are more commonly suited to fixed prostheses due to limitations in time efficiency and material cost when applied to RPD frameworks[7]. In contrast, additive manufacturing, often referred to as rapid prototyping (RP), constructs 3D models through a layer-by-layer deposition process, offering high precision and complexity in a relatively short time[8][9].

This case report illustrates the prosthodontic rehabilitation of a patient presenting with a completely edentulous maxillary arch and a Kennedy's Class I modification 1 partially edentulous mandibular arch. The treatment plan involved a combination of a complete denture for the maxilla and a mandibular fixed anterior prosthesis with a cast partial denture in the posterior region. The anterior fixed partial denture converted our Kennedys class I modification 1 to Kennedy's class 1 situation. The 3 D designing of the framework along with altered cast technique was employed to ensure optimal stress distribution and functional harmony in the mandibular arch. The report underscores the importance of meticulous impression techniques and highlights the integration of conventional and digital approaches for enhanced clinical outcomes.

2. CASE REPORT

A 75-year-old female patient reported to the Department of Prosthodontics, SGT Dental Hospital, with a chief complaint of difficulty in mastication due to multiple missing teeth. Her dental history revealed prior extractions, a maxillary complete denture, and a mandibular removable partial denture. The patient exhibited a philosophical attitude toward her oral condition.

Intraoral examination revealed a completely edentulous maxillary arch and a partially edentulous mandibular arch, with the presence of teeth 33, 34, 43, and 44. The mandibular arch was diagnosed as a Kennedy's Class I with a modification 1(Figure 1). There was no significant relevant medical history.

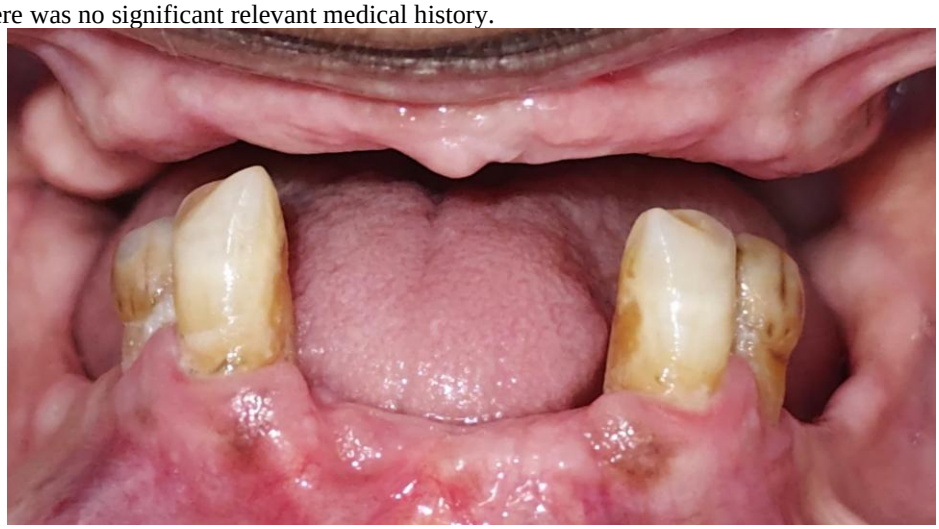

Figure 1- Intra-oral examination

Several treatment options were presented to the patient, including:

1. A fixed implant-supported prosthesis;
2. Anterior mandibular fixed partial denture (FPD) combined with posterior implant-supported prosthesis, along with a maxillary complete denture;
3. Anterior mandibular FPD with a posterior cast removable partial denture (CRPD) and maxillary complete denture;
4. A completely removable prosthesis for both arches.

After thorough discussion, the patient opted for an anterior mandibular FPD with a posterior CRPD and a maxillary complete denture. Hence, the replacement of missing mandibular posterior teeth using a cast partial denture was planned.

The altered cast impression technique was employed, as it enables the functional recording of the edentulous ridge, thereby allowing the final prosthesis to derive optimal support from both the remaining natural teeth and the denture base upon insertion.

3. PROCEDURE

The maxillary primary impression was made using impression compound, followed by the fabrication of a custom tray. Border molding was performed, and a final wash impression was obtained using elastomeric impression material. A master cast was prepared, upon which a baseplate and occlusal rims were fabricated.

Tooth preparation (Figure 2A) was carried out for teeth 33, 34, 43, and 44 to receive a fixed prosthesis. An elastomeric impression (light body and putty) was taken, and the cast was poured using die stone. A wax-up (Figure 2B) was performed for the metal coping, with occlusal embrasure rests carved into the occlusal surfaces of teeth 33, 34, 43, and 44. The wax pattern was then cast, followed by a metal trial (Figure 2C), after which ceramic layering was completed. The fixed partial denture (FPD) from 34 to 44 was cemented in place (Figure 2D).

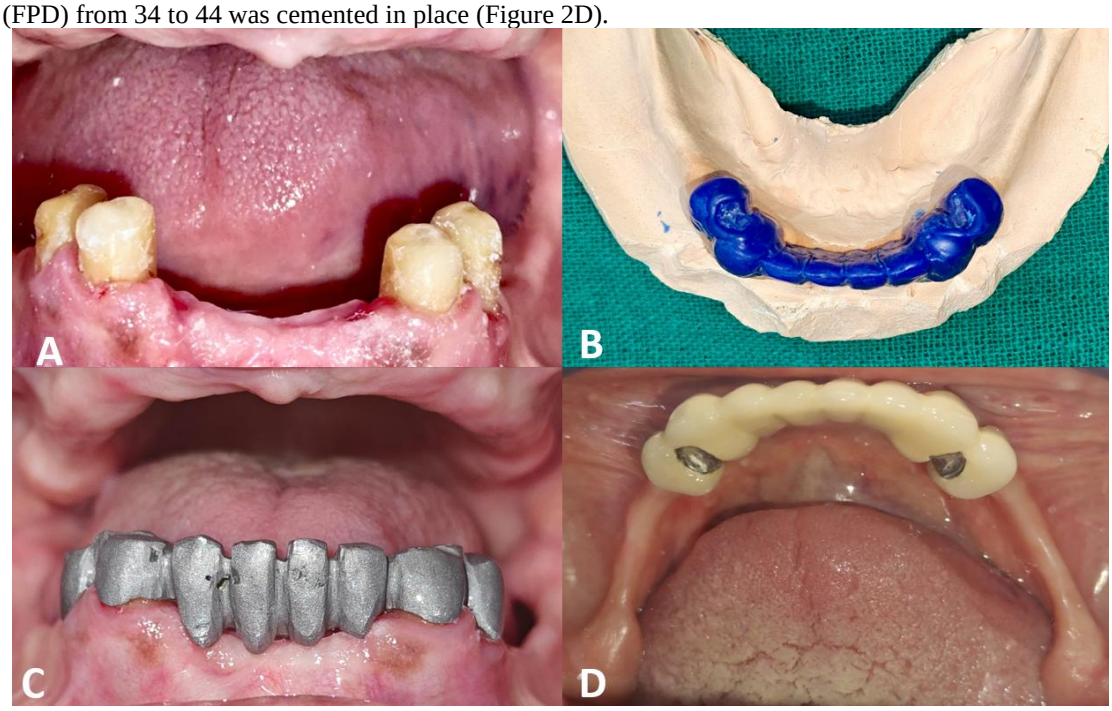

Figure 2 - A: Tooth Preparation wrt 33,34,43&44; B: wax-up; C: Metal Trial; D: FPD cementation.

For the mandibular arch, a primary impression was made using irreversible hydrocolloid (alginate), and a primary cast was poured. A special tray was fabricated, and border molding was carried out. A final wash impression was then made, followed by a pick-up impression using putty. A three-dimensional digital scan of the master cast was obtained, and the scanned model was used for cast partial denture (CPD) designing (Figure 3A). A lingual bar major connector and mesh minor connector were selected, with the Mesial Rest proximal plate and I bar (RPI) concept applied bilaterally.

A resin framework trial (Figure 3B) was conducted prior to metal framework fabrication. The metal framework trial was then performed intraorally(Figure 4B) to evaluate fit and stability.

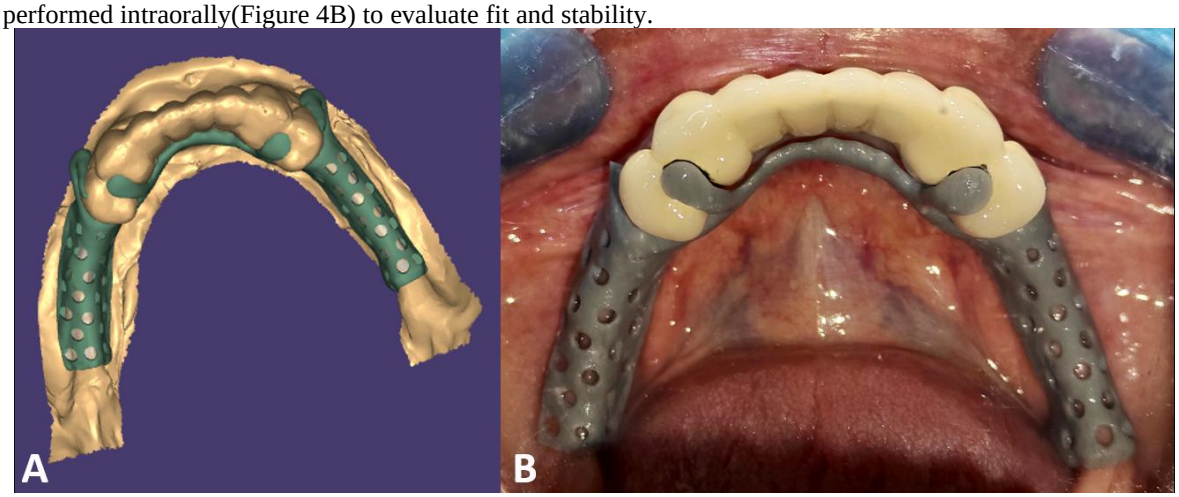

Figure 3- A: Digital designing of CRPD; B:Resin framework trial

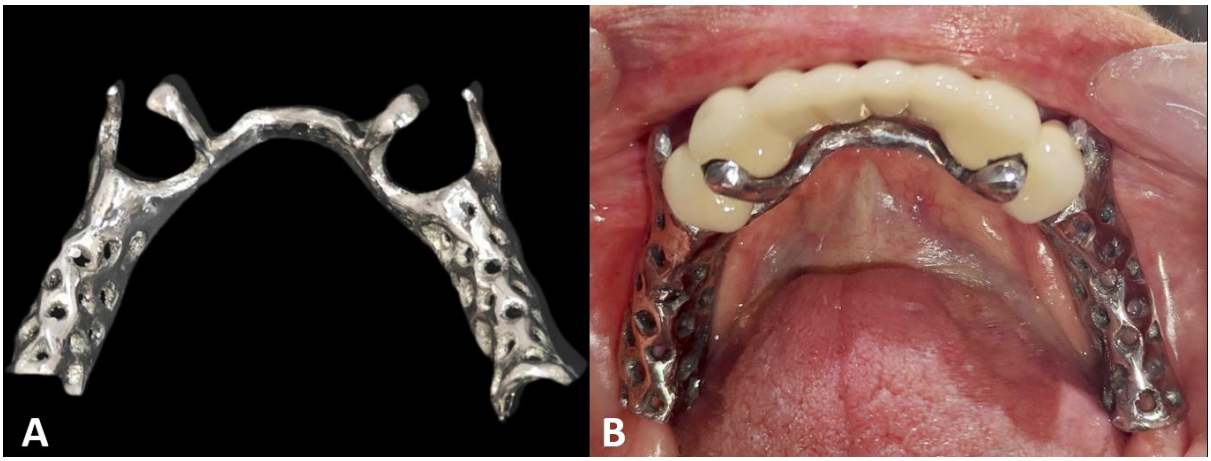

Figure 4- A: Metal framework of CRPD; B: Metal framework trial

For the altered cast impression technique, border molding of the distal extension area was performed using greenstick compound, and a functional impression was made with light body elastomeric impression material (Figure 5).
The master cast was then sectioned to improve adaptation. The first cut was made perpendicular to the edentulous ridge, 0.5–1.0 mm distal to the most distal tooth on each side, extending from the outer edge of the cast to approximately 6.0–7.0 mm medial to the lingual vestibule. The second cut was made parallel and medial to the edentulous ridge, extending from the posterior aspect of the cast to the medial end of the first cut. Retention grooves were incorporated to enhance the retention of newly poured gypsum. The metal framework was seated on the cast and stabilized with sticky wax before beading and boxing were performed. The final impression was poured in dental stone, obtaining the altered master cast (Figure 6), which was subsequently verified for proper framework adaptation.

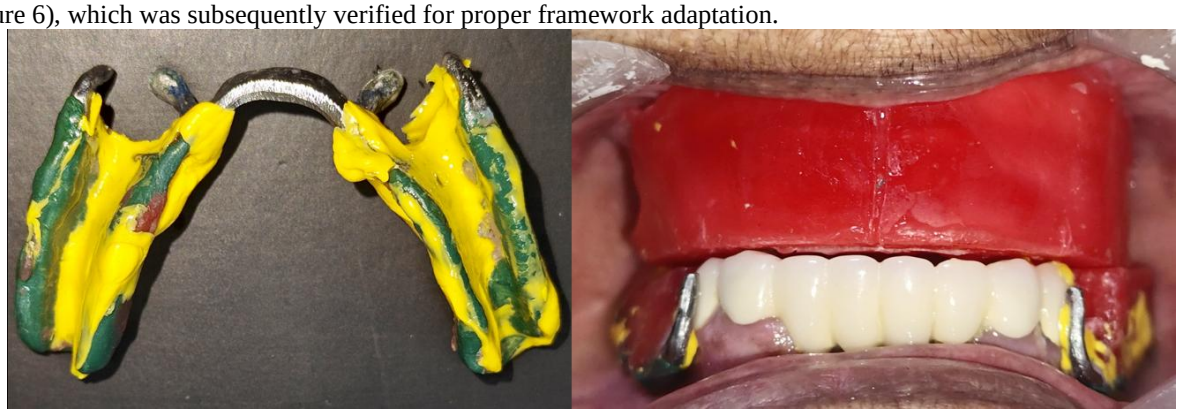

Figure 5- Functional Impression

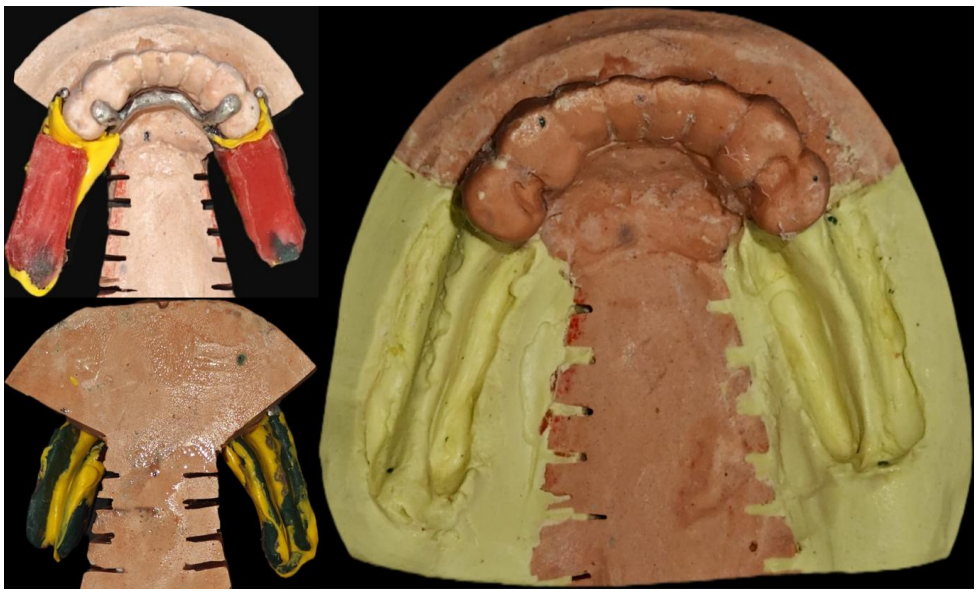

Figure 6 - Altered Master Cast

The subsequent jaw relation, articulation, trial (Figure 7), and denture fabrication were carried out in the conventional manner. The denture was inserted (Figure 8), and post-operative instructions were provided. The patient expressed satisfaction with the outcome of the treatment.

Figure 7- Try-In

Figure 8- Pre And Post Operative Extraoral Photographs

Figure 9- Pre And Post Operative Intraoral Photographs

4. DISCUSSION

The prosthodontic rehabilitation of partially edentulous arches, particularly Kennedy's Class I and II distal extension cases, presents distinct biomechanical and esthetic challenges. Treatment planning in such situations necessitates a nuanced balance between functional stability, preservation of oral structures, and patient-specific factors such as esthetic expectations, systemic health, and financial feasibility. While implant-supported fixed prostheses are widely regarded as the gold standard due to their superior load distribution and fixed nature, their application is often limited in patients with compromised ridge morphology, systemic conditions, or economic constraints[10].

In the present case, implant therapy was deemed unsuitable due to significant bone loss in the labial vestibule area. A comprehensive treatment plan involving bone grafting followed by implant placement would have required additional surgical interventions and prolonged healing time, typically spanning 3–4 months. Moreover, the cost and surgical invasiveness of the procedure deterred the patient from opting for an implant-supported solution. Consequently, a cast partial denture (CPD) was selected, which offered a non-invasive, cost-effective alternative that could restore anterior esthetics, phonetics, and functional efficiency without surgical morbidity[11][12].

CPDs remain a time-tested and biomechanically favorable option in distal extension cases due to their rigid framework, improved load distribution, and capacity to preserve abutment and residual ridge health. In long-span edentulous spaces, anterior teeth often must be engaged for support. While circumferential clasps can compromise esthetics, the use of RPI clasps—although slightly visible—can be acceptable, especially in patients with low to moderate smile lines. In this case, the RPI clasp provided necessary retention and stability with minimal esthetic compromise, a result the patient found satisfactory. Additionally, the maxillary labial flange was strategically extended to compensate for anterior bone loss, enhancing both esthetic and structural outcomes[13][14].

To ensure optimal biomechanical performance and longevity of the prosthesis, the altered cast technique was employed. This technique addresses the limitations of conventional impressions, which fail to capture the functional form of the distal edentulous ridge, leading to excessive stress on abutments, ridge resorption, and instability. By recording the tissues under functional load, the altered cast technique facilitated uniform stress distribution between the abutments and the soft tissue, minimizing post-insertion complications and enhancing patient comfort[15].

Modern prosthodontics has been significantly transformed by digital workflows. The incorporation of computer-aided design and computer-aided manufacturing (CAD/CAM) has streamlined the fabrication of removable partial dentures, offering unprecedented precision, reproducibility, and efficiency [16]. In this case, the CPD framework was digitally designed using CAD software, allowing for:

- Precise customization to the patient's unique anatomical contours
- Optimized placement of occlusal rests and major connectors for effective load transfer
- Accurate adaptation of the lingual bar for enhanced retention
- Elimination of human errors inherent in manual wax-up procedures

The framework was fabricated using additive manufacturing (3D printing) techniques. Rapid prototyping (RP) technologies such as stereolithography (SLA) have emerged as the preferred method for resin-based framework fabrication due to their high-resolution output, superior surface quality, and cost-effectiveness[17][18]. In this case, SLA printing was employed to produce a resin trial framework, allowing for pre-casting evaluation—a distinct advantage over conventional wax patterns, which do not permit intraoral trials prior to casting.

This approach also obviated the need for labor-intensive steps such as block-out, duplication, and wax pattern adaptation, thereby conserving laboratory time and preserving the master cast. Digital surveying and cast design on a 3D e-model ensured accurate identification of desirable and undesirable undercuts. Additionally, the use of biocompatible photopolymer resins that polymerize under UV light provided a framework with excellent strength, fit, and tissue compatibility. Once verified intraorally, the resin pattern was cast in a cobalt-chromium alloy using conventional casting techniques[19].

Innovations such as the twin-flex clasp design—used to reduce torque on abutments while maintaining esthetics—can further enhance CPD function, although they demand high laboratory precision. While attempts to camouflage clasps using tooth-colored resins have been reported, they offer only temporary visual improvement and cannot fully eliminate clasp visibility [20][21].

The final prosthesis in this case—a combination of an anterior fixed partial denture and a posterior CPD—achieved excellent clinical outcomes. The patient reported substantial improvement in masticatory efficiency, esthetic satisfaction, and overall comfort. This case underscores the value of blending time-tested techniques like the altered cast method with modern digital and additive technologies to achieve functionally and esthetically superior outcomes in complex partial edentulism cases.

5. CONCLUSION

The management of Kennedy's Class I distal extension cases remains a challenge due to the biomechanical complexities associated with tooth-tissue-supported prostheses. This case report highlights the successful rehabilitation of a partially edentulous patient using a combination of an anterior FPD and a CAD-designed posterior CPD.

The altered cast impression technique proved to be a crucial step in enhancing the fit and stability of the prosthesis by allowing functional ridge recording and improved stress distribution. Additionally, CAD technology played a pivotal role in ensuring precision, better framework adaptation, and enhanced patient comfort.

With the increasing adoption of digital workflows in prosthodontics, CAD-assisted CPD fabrication presents a promising alternative to conventional techniques by improving accuracy, reducing laboratory processing time, and enhancing prosthetic fit. Future advancements in 3D printing and digital prosthetic design are expected to further refine the fabrication of CPDs, making them even more predictable and efficient.

Clinical Implications:

- The altered cast technique remains essential for distal extension cases, ensuring a functional and stable prosthesis.
- CAD-assisted CPD fabrication enhances framework accuracy, prosthetic fit, and overall patient satisfaction.
- The combination of fixed and removable prostheses can be an effective strategy for restoring function in Kennedy's Class I cases.

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