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RESEARCH ARTICLE
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ENHANCING PROSTHETIC LONGEVITY AND FRACTURE RESISTANCE BY COBALT-CHROMIUM FRAMEWORK INTEGRATION IN MANDIBULAR COMPLETE DENTURES — A CASE SERIES

[*1]Dr.Mithileshwari Patil, [2]Dr. Abhijit Deshpande, [3]Dr.Virsen Patil, [4]Dr.Snehal Shende, [5]Dr.Sampathkumar N., [6] Dr.Karthik S.M, [7]Dr. Nikhil Tantak

[1*]3rd year Post graduate student in Prosthodontics.Tatyasaheb Kore Dental College and Research Centre, New Pargaon , Kolhapur Maharashtra University of Health Sciences (MUHS) mithileshwaripatil@gmail.com
[2]M.D.S in Prosthodontics and Implantology Head of the Department, Department of Prosthodontics Tatyasaheb Kore Dental College and Research Centre New Pargaon,Kolhapur Maharashtra University of Health Sciences (MUHS) abhid2001@yahoo.com
[3]M.D.S in Prosthodontics and Implantology Reader , Department of Prosthodontics Tatyasaheb Kore Dental College and Research Centre New Pargaon ,Kolhapur Maharashtra University of Health Sciences (MUHS) virsenp@gmail.com
[4]M.D.S in Prosthodontics and Implantology Reader , Department of Prosthodontics Tatyasaheb Kore Dental College and Research Centre New Pargaon ,Kolhapur Maharashtra University of Health Sciences (MUHS) snehalshende22@gmail.com
[5]M.D.S in Prosthodontics and Implantology Reader , Department of Prosthodontics Tatyasaheb Kore Dental College and Research Centre New Pargaon ,Kolhapur, cbctgrace@gmail.com Maharashtra University of Health Sciences (MUHS)
[6]M.D.S in Prosthodontics and Implantology Reader , Department of Prosthodontics Tatyasaheb Kore Dental College and Research Centre New Pargaon ,Kolhapur Maharashtra University of Health Sciences (MUHS) smk_bds@yahoo.co.in
[7]3rd year Post graduate student in Prosthodontics. Tatyasaheb Kore Dental College and Research Centre New Pargaon ,Kolhapur Maharashtra University of Health Sciences (MUHS) nikhiltantak@gmail.com

***Corresponding Author:** Dr.Mithileshwari Patil
*3rd year Post graduate student in Prosthodontics.Tatyasaheb Kore Dental College and Research Centre, New Pargaon , Kolhapur Maharashtra University of Health Sciences (MUHS) mithileshwaripatil@gmail.com

Abstract

Polymethyl methacrylate (PMMA), widely used in prosthodontics, often fails under heavy masticatory forces due to low impact strength and fatigue resistance. Cobalt-chromium metal frameworks offer a durable alternative, particularly in complex cases. This case series highlights three examples: a patient with repeated PMMA denture fractures resolved with a cobalt-chromium design, a tongue-tie patient with opposing natural teeth stabilized by a metal framework, and an

OSMF patient with limited oral access successfully rehabilitated using a metal-based denture. While metal frameworks may have aesthetic and weight limitations, their advantages in fracture resistance, longevity, and functionality make them invaluable for challenging clinical scenarios.

Keywords: Cobalt-chromium, metal framework, mandibular denture, PMMA, fracture resistance, occlusal forces, anatomical challenges, oral submucous fibrosis, denture durability

Introduction

Polymethyl methacrylate (PMMA) is widely used in prosthetic dentistry due to its lightweight nature, aesthetic appeal, affordability, and ease of manipulation. These properties make it a preferred material for complete dentures. However, PMMA has mechanical limitations particularly its low impact strength and poor fatigue resistance.[1] Under heavy masticatory stress, especially in patients with strong occlusal forces, PMMA dentures are prone to midline fractures.[2]

These limitations become critical in patients with opposing natural dentition, fixed partial dentures (FPDs), or complex oral anatomy. In such situations, cobalt-chromium (Co-Cr) metal frameworks offer a more durable alternative. Their superior strength and ability to distribute stress evenly improve both function and longevity [3,4] This case series presents three clinical examples where Co-Cr frameworks successfully addressed challenges typically faced by PMMA-based dentures.

Case 1: Recurrent Denture Fractures

A 65-year-old male with no significant medical history reported repeated midline fractures of his mandibular denture, primarily in the lower central incisor region. Two previous prosthesis had failed in the same area, prompting his request for a more durable solution.

Case 2: Anatomical Challenges and Occlusal Stress

A 53-year-old male with a fully edentulous mandible and partially edentulous maxilla reported difficulty in chewing. Missing posterior molars caused increased load on the mandibular ridge. The patient also had a tongue-tie and a severely resorbed mandibular ridge, though he declined surgical correction.

Case 3: Limited Oral Access and Fixed Dentition

A 54-year-old hypertensive male presented with reduced mouth opening due to oral submucous fibrosis (OSMF) caused by chronic tobacco use. He had a completely edentulous mandible opposing a maxillary fixed partial denture. Due to limited mouth opening and high occlusal forces from the opposing FPD a mandibular denture reinforced with metal framework was planned for this case.

Prosthetic Workflow and Follow-Up

In Case 1, the primary impression was taken using impression compound. A custom tray was fabricated, followed by border moulding and final impression. The mandibular cast was poured in dental stone, and a ladder-type bar framework was digitally designed using Exocad to enhance fracture resistance and reduce denture weight. The design included 2 mm relief for acrylic and two posterior tissue stops. The framework was printed using DMLS technology and finished. Three 1 mm acrylic tissue stops (one anterior, two posterior) were added to stabilize the framework on the master cast before jaw relation. (Figure 1). [2]

In Case 2, the maxillary impression was made using alginate, and the mandibular with impression compound using the admixed technique. A custom tray was fabricated. A functional impression was made for the maxillary distal extension. Due to a resorbed mandibular ridge and tongue tie, the mandibular final impression was recorded using McCord and Tyson's all-green technique, with minimal border moulding in the anterior region. The mandibular framework planned was a hybrid design with a thin anterior plate and posterior meshwork. A 2 mm spacer was adapted posterior to the canines for acrylic space on master cast. Then after providing all the necessary relief area and blockout, master cast was duplicated and investment cast was made. Wax pattern (Bego) with two

retentive tags for acrylic retention and framework stability was fabricated and conventional casting of framework was done. Then framework was finished and polished (Figure 2 and 3).
In Case 3, the maxillary impression was taken using alginate, and the mandibular with impression compound. After custom tray fabrication, functional impressions was taken for maxillary distal extension RPD and mandibular final impression using green stick compound and light body material. The mandibular metal framework featured a thin plate with nail bead extensions for mechanical retention with three tissue stops (one anterior and two posterior) (Figure 4). DMLS printing of framework was carried out after designing with Exocad software.
For all three cases, after framework fabrication, intraoral trials were done to evaluate fit and adjust overextensions if present. Facebow records and jaw relations were obtained and mounted on a Hanau articulator. Teeth arrangement, try-in, occlusal equilibration and conventional denture processing was done. (Figure 5-7). Dentures were delivered with post-insertion instructions (Figure 8). Follow-ups at 3 months, 6 months, 1 year, and 3 years showed stable results, with all patients reporting improved comfort, function, and satisfaction.

Discussion

Although PMMA remains the standard denture base material due to its aesthetic and economic advantages, its mechanical limitations can lead to frequent midline fractures especially in mandibular prostheses under high occlusal stress. [1,2] Co-Cr frameworks address these issues by reinforcing the denture base and improving longevity.
In Case 1, a cobalt-chromium metal framework was used to reinforce the mandibular denture due to the patient's history of repeated fractures. A ladder-type design was selected to reduce metal volume and denture weight while maintaining strength and allowing future relining or rebasing. Studies such as Rathee et al. (2022) confirm cobalt-chromium's ability to resist high masticatory forces and reduce midline fractures.[5] Instead of traditional casting; DMLS was employed for its precision in creating uniformly spaced lattice windows, as recommended in other studies.[6]

Case 2 involved a patient with a tongue tie, limiting tongue mobility and affecting denture stability. Increased thickness of metal framework compared to PMMA contributed to gravitational retention in the lower denture.[7] Due to the presence of anterior maxillary teeth and lack of posterior support, occlusal forces were focused on the mandibular ridge. The framework helped distribute these stresses more evenly across the basal seat, minimizing ridge resorption. A hybrid design with narrow lingual flange, thin anterior metal base, and posterior meshwork was chosen to avoid impinging the frenulum while improving stability.[8] Traditional casting was preferred over DMLS in this case due to lower cost and easier chairside and lab adjustments, which are important in tongue-tied patients where intraoral modifications may be necessary.

In Case 3, the patient with OSMF and restricted mouth opening required a prosthesis that resists the forces from an opposing FPD. A hybrid framework with a single thin plate and nail bead extensions was used to improve dimensional stability and distribute masticatory loads effectively. The cobalt-chromium framework provided the needed fracture resistance while allowing ease of insertion despite the limited opening.[8] DMLS was chosen over traditional casting to achieve uniform plate thickness and consistent nail bead size and positioning, difficult to replicate with manual wax-up.
Overall, Co-Cr frameworks distribute masticatory forces more evenly across the basal seat, reducing stress concentrations and minimizing the risk of fracture. [4,8] They are especially beneficial for patients with parafunctional habits, anatomical constraints, or a history of denture fractures. Despite their advantages, metal frameworks have drawbacks. Esthetically, they lack the translucency of PMMA or ceramics. Veneering can improve appearance but increases complexity and cost. Additionally, metal dentures are heavier and may feel less comfortable initially.[9] Fabrication and repairs also require specialized tools and expertise, adding to cost. However, their durability and reduced maintenance often justify the investment.[10]

Future developments such as hybrid metal-ceramic frameworks, lighter biocompatible alloys, and enhanced 3D printing technologies may improve aesthetics, reduce weight, and streamline production processes.[6]

Conclusion

Cobalt-chromium frameworks provide a strong, durable, and clinically effective alternative to PMMA in mandibular complete dentures, particularly in patients with high occlusal loads or anatomical challenges. While considerations such as weight, aesthetics, and cost must be addressed, their mechanical advantages make them a valuable option in complex prosthodontic cases. Continued advancements in materials and digital workflows are expected to expand their utility and enhance patient outcomes.

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Source of Funding:NIL

Informed Consent

Written informed consent was obtained from all patients included in this case series for the use of their clinical data and images for academic and publication purposes. The patients were assured of confidentiality and anonymity, and their identities have been protected by ethical guidelines.

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Figures:

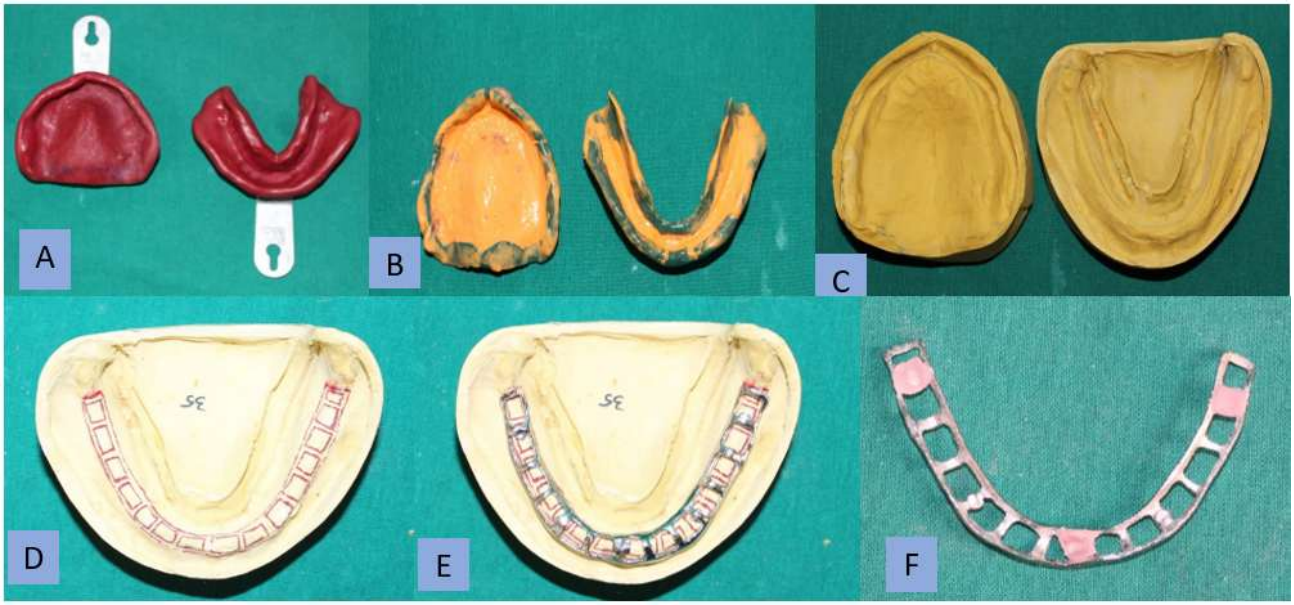

Figure 1: Impression and Framework Workflow – Case 1
(A) Primary impressions using impression compound in stock trays (maxillary and mandibular).
(B) Final impressions with light body in custom trays.
(C) Master casts.
(D) Master cast with lattice-window type metal framework design.
(E) Finished framework adapted on master cast.
(F) DMLS-fabricated cobalt-chromium framework with three acrylic tissue stops

Figure 2: Maxillary and mandibular master casts - Case 2

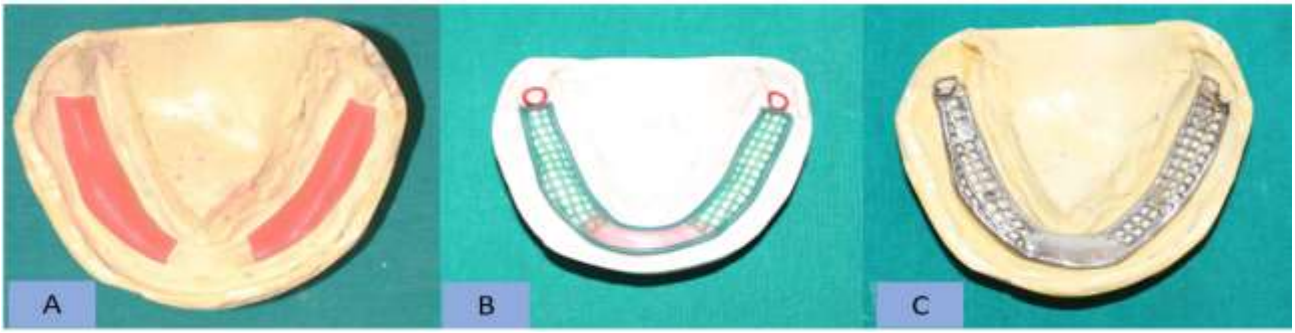

Figure 3:Framework Planning of Case 2
(A) Spacer wax adaptation in posterior region on master cast before duplication.
(B) Design of hybrid metal framework on investment cast after duplication
(C) Master cast with cobalt-chromium framework.

Figure 4: Clinical Workflow of Case 3
(A) Maxillary and mandibular primary impressions.
(B) Mandibular border moulding and final impression with light body.
(C) Framework design on master cast with tissue stops.
(D) Finished hybrid framework with thin plate and nail bead extensions.

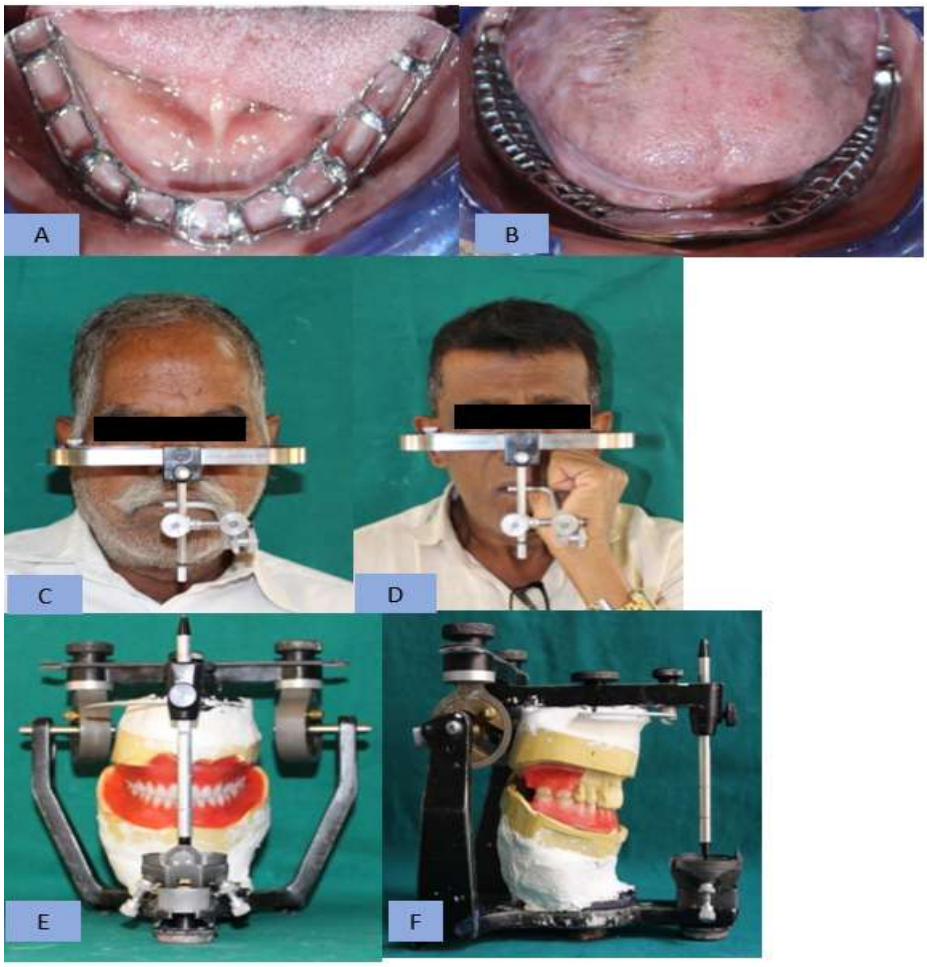

Figure 5: Intraoral Framework Trials,Jaw Relation and Mounting
(A) Intraoral view of Case 1 showing accurate adaptation of the DMLS-fabricated cobalt-chromium framework with uniform tissue stops and retentive windows.

(B) Intraoral view of Case 2 showing well-adapted hybrid metal framework with a narrow anterior metal plate and posterior mesh design, allowing for functional space in a tongue-tied patient with resorbed ridge.
(C,D) Facebow transfer in Case 1 and Case 2, respectively
(E,F) Mounted maxillary and mandibular casts with arranged teeth on Hanau articulator – Case 1 and 2, respectively

Figure 6(A,B,C): Intraoral Try-In of Dentures of all three cases

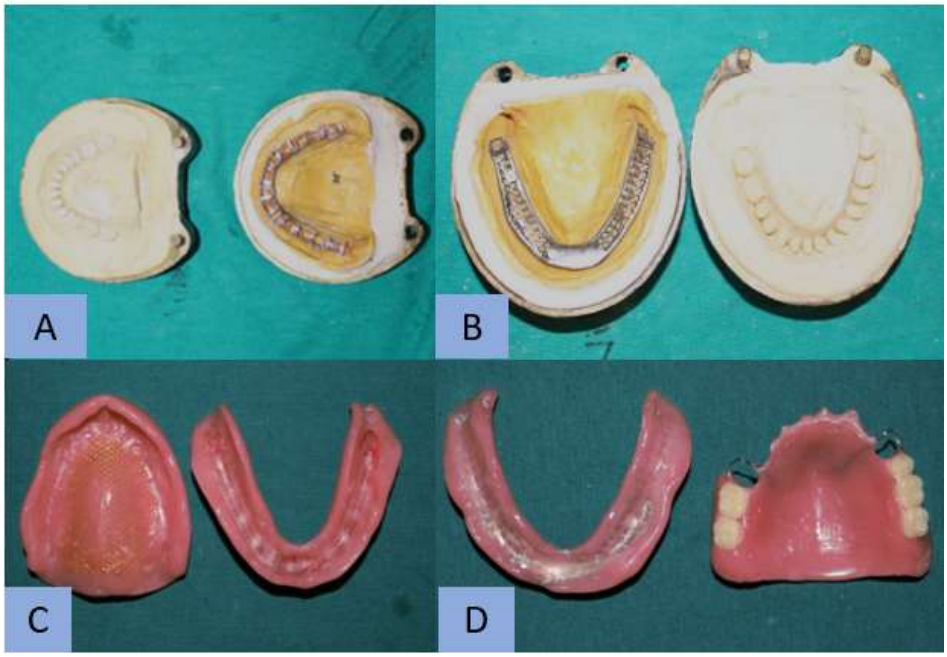

Figure 7: Processing and Intaglio Surface of Metal-Reinforced Dentures – Cases 1 and 2
(A,B)-Processing of dentures(Case 1 and 2,respectively)
(C,D)- Intaglio surface of processed dentures with metal framework(Case 1 and 2, respectively)

Figure 8:Extraoral post operative pictures of Case 1,2 and 3(A,B and C) after denture delivery