

Original Article

## Finite Element Analysis of Stress Distribution and Deformation in Maxillary Distal-Extension Removable Partial Dentures Fabricated from CoCr and PEEK

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### Abstract

The Present Investigation Was Designed To Map The Mechanical Stress Propagation And Resulting Distortion In Maxillary Bilateral Distal-Extension Removable Partial Dentures (Rpd) Manufactured From Cobalt-Chromium (Cocr) And Polyetheretherketone (Peek), With Particular Scrutiny On The Abutment Tooth, Periodontal Ligament (Pdl), Mucosal Tissue, And The Structural Framework. Starting From The Subject's Cone-Beam Computed Tomography (Cbct) Imagery And A Digitized Master Cast, A Three-Dimensional Maxillary Representation Was Produced, Featuring Six Anterior Maxillary Teeth. U-Shaped Palatal Major Connectors For Both The Cocr And Peek Rpd Variants Were Modeled Using Computer-Aided Design (Cad) In Solidworks 2017 (Solidworks Corp., Waltham, Ma, Usa). A Symmetrical Vertical Load Amounting To 320 N Was Delivered Onto The Bilateral Posterior Prosthetic Teeth. Three-Dimensional Finite Element Modeling Was Used To Determine Von Mises Stress (Vms) Fields Across The Abutment, Pdl, Mucosa, And Framework For Both Material Groups. In Contrast, The Framework's Structural Deflection Was Quantified Using Ansys Workbench 2020 (Ansys Inc.). Stress Originated In The Free-End Saddle Region And Radiated Toward The Mucosal Surface, The Abutment, And The Pdl. Among Oral Anatomical Structures, The Highest Stress Magnitude Was Recorded At The Abutment, Declining Subsequently Through The Mucosa To The Pdl. The Vms Localized At The Abutment Under The Cocr Rpd Condition (9.098 Mpa) Proved Greater Than That Recorded For The Peek Rpd (7.515 Mpa). Yet, The Vms Values At The Mucosa And Pdl Were Broadly Equivalent Between The Two Material Systems. Divergent Stress Distribution Profiles Emerged Depending On The Framework Material. The Peak Vms Sustained By The Cocr Framework (107.99 Mpa) Was Substantially Superior To That Borne By The Peek Framework (11.7 Mpa). By Comparison, The Maximum Vertically Oriented Deflection Of The Peek Framework (0.0128 Mm) Exceeded The Corresponding Measurement For The Cocr Framework (0.0082 Mm). These Data Suggest A More Favorable Protective Capacity Of The Peek Rpd Toward The Abutment. Neither The Peek Nor The Cocr Rpd Appeared Predisposed To Cause Notable Mechanical Insult To The Mucosal Tissues Or The Pdl. Even So, The Cross-Sectional Bulk Of The Peek Framework Warrants Careful Consideration To Attenuate Stress Conveyance To The Residual Ridge Mucosa.

**Keywords:** Polyetheretherketone, Cobalt-chromium, Removable partial denture, Finite element analysis

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### Introduction

Removable partial dentures (RPDs) have persisted as a tooth-replacement modality for many decades, favored for their conservative preparation requirements and

economic accessibility, and they can restore masticatory function and facial harmony. Several clinical scenarios warrant their prescription: situations in which a fixed prosthesis cannot achieve sufficient retention, expansive edentulous spans lacking a

posterior terminal abutment, cases involving compromised periodontal anchorage of the standing dentition or alveolar ridge resorption, and requirements for cross-arch bracing [1].

An RPD integrates multiple structural elements that collectively dictate its operational efficacy, the durability of the distal abutment, and the continue health of the investing soft and hard tissues. Clasp geometry and rest placement both modulate the distribution of functional forces within the supporting complex. Adopting a stress-relieving clasp assembly, such as the RPI design, within a distal-extension base offloads the abutment [2]. The major connector, a foundational component of any RPD framework, must provide sufficient stiffness to function efficiently and to shield the underlying soft tissue; however, its ultimate configuration may be shaped by intraoral anatomy, patient tolerance thresholds, and the spatial requirements of the denture base [3].

When considering maxillary major connectors, the anteroposterior palatal strap offers the greatest structural rigidity and the least flexure, making it the preferred configuration for distal-extension situations. It is followed by the palatal strap, which provides satisfactory rigidity while offering somewhat reduced resistance across extensive spans. The palatal plate achieves high stiffness when broad, but may compromise patient comfort due to generous tissue coverage. The U-shaped palatal connector ranks as the least advantageous, being most liable to flex and offering deficient cross-arch stabilization, and ought only to be selected when dictated by unavoidable anatomical constraints [4, 5]. For illustration, encountering a torus palatinus may necessitate either a paired anterior–posterior palatal strap or a U-shaped palatal connector. Otherwise, excision of the torus palatinus becomes requisite when a palatal plate or strap design is favored [6]. However, surgical removal may be contraindicated by the patient's systemic condition or personal disinclination toward operative intervention. Should the U-shaped palatal major connector be chosen, nevertheless, the inherent rigidity of the construction material must remain a central concern [4, 5, 7].

Materials suited for RPD fabrication can be broadly classified into metallic and non-metallic categories. Cobalt–chromium (CoCr) alloy is the predominant metal used in traditional RPD frameworks because it offers a combination of high strength and stiffness, can be produced in slender sections, responds to thermal stimuli, and demonstrates corrosion resistance [8]. Its shortcomings include an unattractive appearance, a perceptible metallic taste, and the potential to provoke

hypersensitivity reactions in susceptible individuals [9, 10]. Polyetheretherketone (PEEK) is a modern, metal-free alternative that has only recently been adopted in restorative dentistry [11]. PEEK is a semi-crystalline organic thermoplastic characterized by an aromatic backbone wherein ketone and ether linkages alternate between aryl rings. It displays an array of advantageous properties: low density, outstanding biocompatibility, tooth-colored esthetics, an elastic modulus approximating that of cortical bone, chemical resilience, and resistance to both thermal degradation and abrasive wear [12]. Owing especially to its reduced weight, favorable aesthetics, and metal-free formulation, the PEEK framework has emerged as a viable alternative to the conventional CoCr framework [13].

At present, finite element analysis (FEA) has become a pervasive computational methodology in dental research for probing stress distributions, structural deformations, and load-transfer pathways within oral tissues and prostheses, including RPDs. It permits exploration of clasp configurations, major connector morphologies, and material behaviors, thereby assisting in design optimization and biomechanical enhancement of RPDs [14]. FEA offers a range of benefits: non-invasive virtual experimentation, granular stress mapping, iterative design refinement, and cost savings in both time and resources; however, its fidelity depends heavily on precise material parameter assignment, accurate geometric reconstruction, and corroboration through clinical observational data [15, 16]. Several FEA-based publications have reported that PEEK clasp assemblies develop diminished retention relative to their CoCr counterparts [17-19]. In addition, both PEEK clasps and frameworks have been shown to transmit lower stress magnitudes to the abutment teeth and mucosa than CoCr RPDs, suggesting meaningful biomechanical benefits [19, 20]. Such observations underscore the importance of judicious material selection in prosthodontic planning, as PEEK frameworks can mitigate loads on the supporting apparatus.

Even though isolated clinical case reports have reported favorable patient experiences with PEEK-based RPDs [21-23], the literature addressing PEEK frameworks that incorporate a U-shaped palatal major connector in broad, partially dentate maxillary arches with distal extension remains sparse.

In light of this, the objective of the present work was to interrogate the stress dispersion and deformation behavior of CoCr as opposed to PEEK RPDs within maxillary bilateral distal-extension contexts, centering

on the abutment, periodontal ligament (PDL), mucosal bed, and the RPD framework, through the lens of FEA.

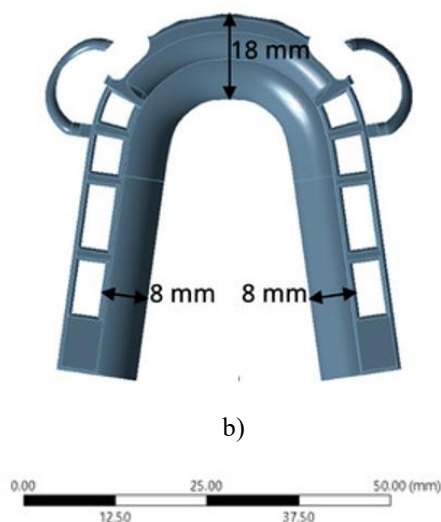
## Materials and Methods

A three-dimensional maxillary construct was sourced from an individual presenting with distal-extension edentulism on both sides, classified as Kennedy Class I. Imaging was conducted via cone-beam computed tomography (CBCT) (Whitefox®, Acteon Ltd., Norwich, UK), capturing the right and left maxillary sectors at a radiation output of 60 microsieverts ( $\mu\text{Sv}$ ). These data were acquired at the Faculty of Dentistry, Khon Kaen University, to enable three-dimensional finite element model simulation. Authorization for the experimental methodology was granted by the Center for Ethics in Human Research at Khon Kaen University (Reference: HE662011). The FEA procedure was partitioned into three core steps: pre-processing, solving, and post-processing. A detailed account of each step is provided in the subsequent sections.

### Pre-processing step

#### Model construction

The three-dimensional finite element representations were created using computer-aided design (CAD) in SolidWorks 2017 (SolidWorks Corp). The scanned maxillary model included six anterior maxillary teeth, fitted with cingulum rests on both the right and left maxillary canines, along with a PDL measuring 0.2 mm in width, palatal mucosal tissue of 2 mm thickness, and the underlying alveolar bone [20]. The RPD assembly, comprising the prosthetic teeth, the structural framework, and the acrylic resin base, was built on this maxillary template. **Figures 1a and 1b** illustrates the RPD arrangement intended for fabrication from the two different substances, as explained hereafter:



**Figure 1.** RPD design for CoCr and PEEK RPD models in occlusal view: (a) RPD design; (b) RPD framework. Both the CoCr and PEEK versions shared the same layout, differing only in the thickness of the main connector: the CoCr variant was set to 1 mm, whereas the PEEK variant was set to 2 mm.

(1) CoCr RPD: The design incorporated a U-shaped palatal major connector. The segment comprising the band linking the retentive framework to the palatal mucosal surface measured 8 mm. The portion where the band traverses the middle third of the palatal face of the maxillary anterior teeth and continues onto the palatal mucosa spanned 18 mm. I-bar clasp assemblies were placed on the right and left maxillary canines. A uniform major connector thickness of 1 mm was maintained throughout, and the material employed was CoCr alloy.

(2) PEEK RPD: The configuration duplicated that of the CoCr model, with the distinction that the major connector was built to a standardized thickness of 2 mm and was composed of PEEK material.

#### Mesh generation

A tetrahedral element geometry was selected for the discretization process, chosen to achieve geometric consistency throughout the mesh. Individual elements were sized at 0.6 mm. For the maxillary model fitted with the CoCr RPD, the total element count approached 418,032, yielding roughly 752,351 nodal points. For the PEEK RPD assembly, the sum of elements was approximately 429,100, corresponding to about 771,435 nodes.

#### Material mechanical properties for FEA

To facilitate a simplified computational analysis, all constituent materials were assumed to behave

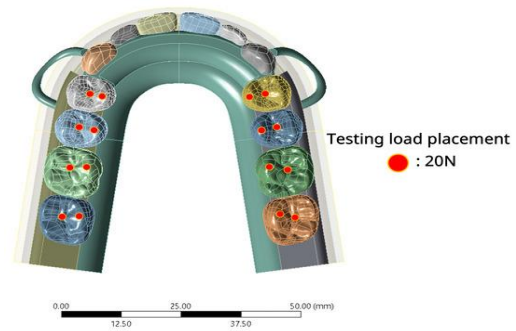
isotropically, homogeneously, and linearly elastically. **Table 1** summarizes the mechanical characteristics assigned to every component of the model.

**Table 1.** Mechanical properties of components used in the finite element models.

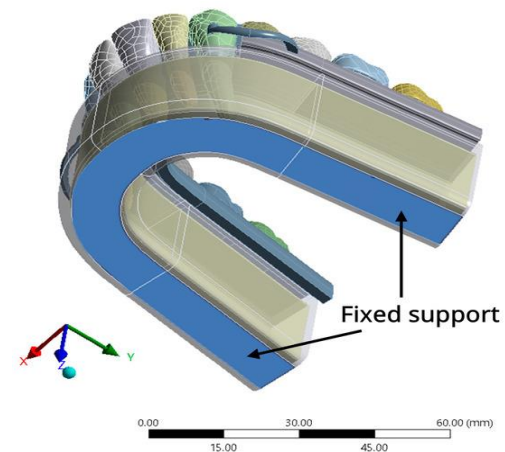
| Material/Tissue Structure                   | Elastic modulus (GPa) | Poisson's ratio |
|---|-----------------------|-----------------|
| Enamel [24]                                 | 41.1                  | 0.35            |
| Dentin [24]                                 | 18.6                  | 0.35            |
| Cementum [25]                               | 15.4                  | 0.31            |
| Periodontal ligament [24]                   | 0.0004                | 0.49            |
| Residual ridge mucosa [26]                  | 0.03736               | 0.49            |
| Cortical bone [24]                          | 11.76                 | 0.25            |
| Cancellous bone [24]                        | 1.47                  | 0.3             |
| Acrylic resin and artificial dentition [24] | 2.45                  | 0.3             |
| Cobalt–chromium alloy (CoCr) [20]           | 235                   | 0.33            |
| Polyetheretherketone (PEEK) [20]            | 4.1                   | 0.4             |

#### Constraints and force application

For the purpose of mimicking occlusal loading, a total vertically directed biting force of 320 N was delivered bilaterally onto the occlusal tables of every posterior artificial tooth belonging to the RPD on both the left and right sides [27]. The precise locations of force introduction on the prosthetic teeth are mapped in **Figure 2**. The vertical force was imparted at two designated spots per tooth—namely, the central fossa and the palatal cusp—with each point receiving 20 N. The maxillary bone foundation was immobilized completely in all spatial directions, as represented in **Figure 3**. Each interproximal contact area between teeth, the boundary where the tooth meets the RPD framework, and the junction between the residual ridge mucosa and the denture base were all defined in a bonded state, constrained by computational capacity limitations. This modeling choice treated these interfaces as perfectly fused, eliminating the possibility of slippage or gap formation and thereby permitting a computationally efficient simulation of the large, multi-component RPD system.



**Figure 2.** Location of testing load placement on the central fossa and palatal cusp of artificial teeth.



**Figure 3.** The fixed support area was fixed to the base of the maxillary bone (blue-colored area).

#### Solving step and post-processing step

The simulation was executed using the ANSYS Workbench platform (ANSYS Workbench 2020; ANSYS Inc.). The inquiry focused on mapping von Mises stress (VMS) fields within the abutment, PDL, residual ridge mucosa, and RPD framework, and on quantifying the framework's displacement along the Z-axis (vertical).

#### Results and Discussion

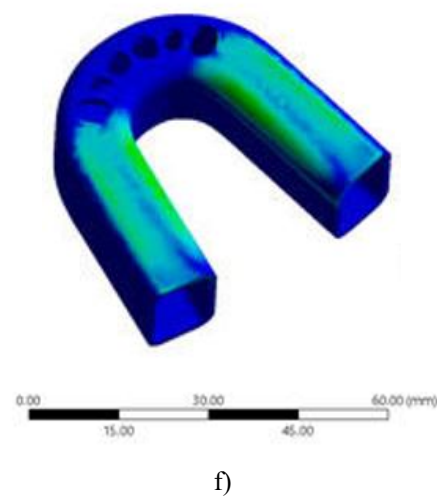
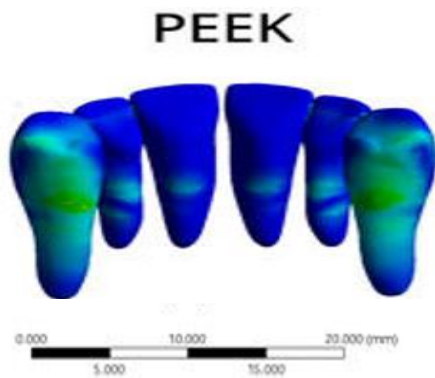
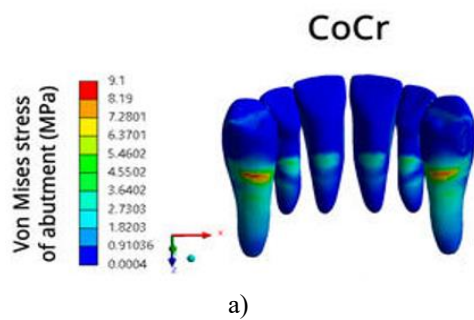
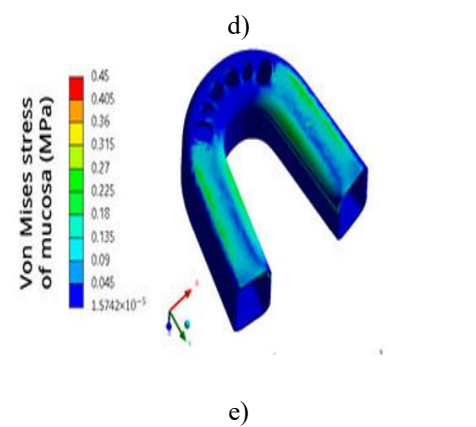
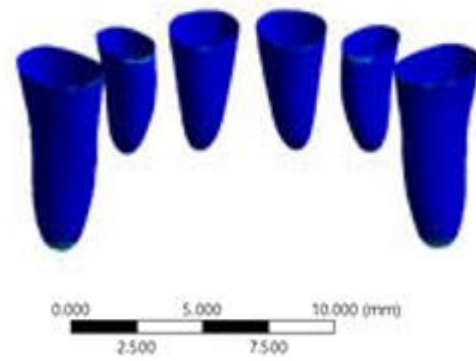
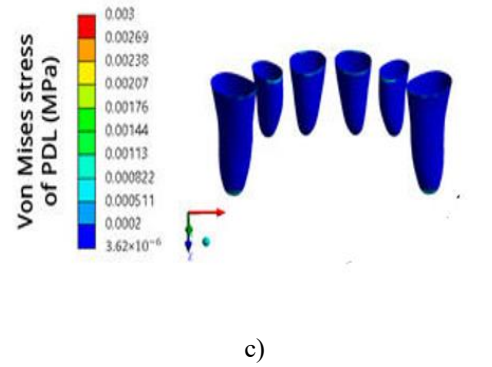
Once the masticatory load engaged the posterior prosthetic teeth of the RPD, the stress pattern arose from the distal extension segment of the prosthesis. It extended outward into the residual ridge mucosa, the abutment, and the PDL. The greatest VMS magnitude was registered at the abutment, with the mucosa coming next, followed by the PDL. A side-by-side evaluation of the peak VMS at the abutment indicated that the CoCr RPD model sustained higher stress (9.098 MPa) than its PEEK RPD counterpart (7.515 MPa). However, the stresses experienced at the mucosa and PDL did not differ significantly between the CoCr and PEEK RPD systems (**Table 2**).

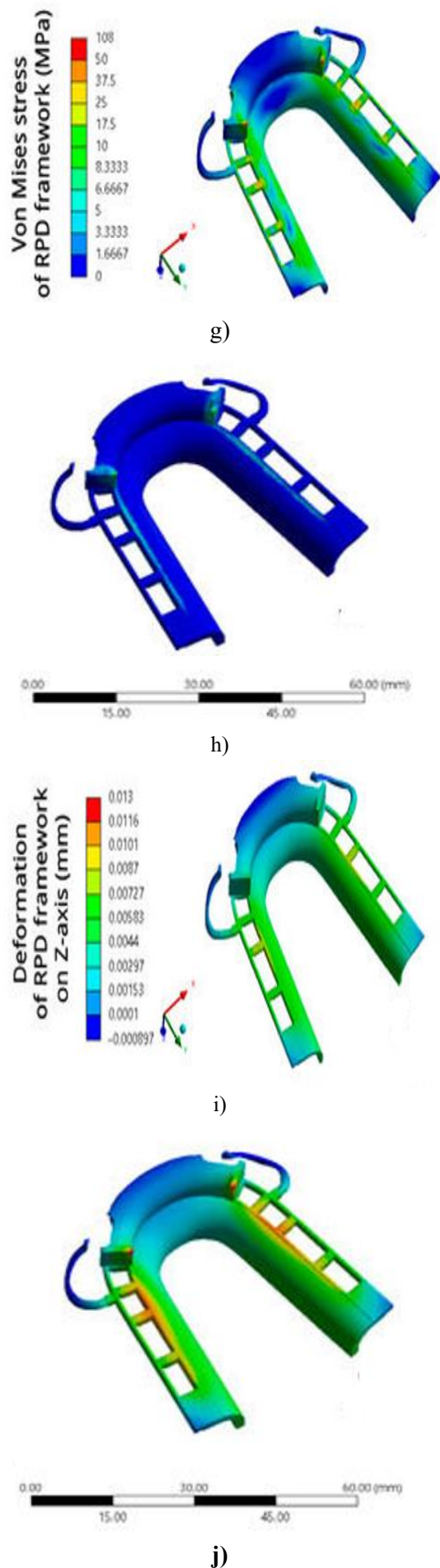
**Table 2.** Maximum von Mises stresses of abutment tooth, periodontal ligament, residual ridge mucosa, and RPD framework in CoCr and PEEK RPD models.

| Component               | CoCr RPD model (VMS, MPa) | PEEK RPD model (VMS, MPa) |
|-------------------------|---------------------------|---------------------------|
| Abutment tooth          | 9.098                     | 7.515                     |
| Periodontal ligament    | 0.003                     | 0.002                     |
| Residual ridge mucosa   | 0.353                     | 0.442                     |
| Denture framework (RPD) | 107.99                    | 11.7                      |

Abbreviations: CoCr = cobalt–chromium; PEEK = polyetheretherketone; VMS = von Mises stress.

**Figure 4a** and **B** portrays how stress was patterned across the palatal sides of the abutment teeth. Within the CoCr RPD simulation, the stress affecting both the right and left maxillary canine abutments was clustered from the cervical third down to the middle third of the root, and the critical stress zone, highlighted in red, was concentrated at the cervical portion (9.098 MPa) (**Figure 4a**). Conversely, the PEEK RPD simulation (**Figure 4b**) showed a stress distribution extending from the cervical third to the middle third along the palatal aspect, continuing over the distal crown surface, and progressing toward the cervical and middle root thirds. Here, the peak stress was also centered in the cervical region of the palatal side but had a lower magnitude (7.515 MPa) than in the CoCr model.





**Figure 4.** Von Mises stresses of CoCr and PEEK RPD model in (a, b) abutment; (c, d) PDL; (e, f) mucosa; (g, h) RPD framework; and (i, j)

deformation of CoCr and PEEK RPD framework on Z-axis under vertical loading.

**Figure 4c, D** capture the stress landscape within the PDL on its palatal aspect, where the patterns between the CoCr and PEEK simulations were noticeably more alike, with the peak VMS values recorded in the PDL being closely matched: 0.003 MPa for the CoCr RPD configuration and 0.002 MPa for the PEEK RPD configuration.

The residual ridge mucosa showed a comparable stress distribution pattern between the two RPD variants, one made from CoCr and the other from PEEK (**Figures 4e and 4f**). Elaborating on this point, the stress spread continuously around the toothless posterior sectors of the maxilla on both the right and left sides, as shown in green, with the highest VMS value at the mucosal level equaling 0.442 MPa in the PEEK model and 0.353 MPa in the CoCr model.

A clear contrast emerged when examining stress patterns within the frameworks themselves: the load concentrated in the CoCr framework (107.99 MPa) was roughly 9 times that in the PEEK framework (11.7 MPa) (**Figures 4g and 4h**). For the CoCr framework, stress was apportioned somewhat symmetrically across the right and left proximal plates, the retentive meshwork, and the junction zone bridging the major connector to the retentive assembly (**Figure 4g**). Regarding the PEEK framework, an equivalent bilateral symmetry governed the stress layout, though a larger share of the stress focused on the proximal plate and retentive meshwork (**Figure 4h**).

Turning to the Z-axis (vertical) displacement, both framework materials behaved elastically. The deformation profiles of the CoCr (0.0082 mm) and PEEK (0.0128 mm) frameworks were similar. As illustrated in **Figures 4i and 4j**, virtually every segment of the framework bent downward; the sole exceptions were the anterior rim of the palatal plate overlaying the front teeth and the terminal tips of the I-bar clasps on each side, depicted in dark blue to denote an upward deflection. The peak deformation magnitude achieved by the PEEK framework (0.0128 mm) exceeded that of the CoCr framework (0.0082 mm).

RPDs are the prosthetic modality of choice for restoring dentition in patients with a long edentulous span, as seen in Kennedy Class I or II arches. Since a distal-extension appliance of this sort is reliant on both teeth and soft tissue for support, its primary buttressing comes from the mucosa and ridge underlying the denture base. In contrast, the abutment teeth furnish secondary support. An RPD must be judiciously

planned to maximize retention and functional steadiness and to restrain prosthesis motion, thereby lessening the load transmitted to the abutment and neighboring oral tissues. The clasp assembly requires careful engineering to ensure appropriate retention and favorable stress distribution. The denture base ought to encompass the greatest possible coverage of the mucosa and residual ridge, producing a snowshoe-type mechanism that partitions occlusal forces uniformly across the supporting tissues [1]. Hence, the major connector, which serves as the skeleton of the denture base, plays a decisive role and demands careful consideration during the framework design process.

Within the confines of this study, a U-shaped palatal major connector scheme was selected for the maxillary bilateral distal-extension RPD, together with I-bar clasps and cingulum rests seated on the right and left maxillary canines. Recognizing that frameworks carved from dissimilar substances exhibit differing degrees of flexure—giving rise to potentially divergent stress landscapes throughout the oral complex—two contrasting materials were evaluated. The PEEK-based RPD was designed identically to its CoCr counterpart, with the sole exception that the framework thickness was twice that of its CoCr counterpart, per the material manufacturer's directives [17, 22]. The resultant stress fields across the abutment, PDL, and mucosa proved broadly analogous when comparing the CoCr and PEEK RPDs. For instance, as the posterior prosthetic teeth that were attached to the free-end base received the applied load, that load was transferred sequentially from the RPD extremity to the mucosal bed, the abutment, and ultimately the PDL. The stress peaked at the abutment, with diminishing magnitudes in the mucosa and PDL, respectively. The canine abutments experienced the highest stresses because, upon vertical loading of the posterior segment, the denture base was pressed into the supporting tissues, provoking a rotational torque that channeled force to the terminal abutment adjacent to the extension base, which served as the pivot point [1]. The CoCr RPD imparted an elevated VMS (9.098 MPa) to the maxillary canines in comparison with the PEEK RPD (7.515 MPa), a disparity likely explained by the markedly lower elastic modulus of PEEK (4.1 GPa) relative to CoCr (235 GPa). The greater pliability inherent in the PEEK material may confer a more protective role toward the abutment tooth. Excessive stress concentration on the residual dentition can hasten PDL destruction and precipitate abutment tooth loss, and amplified PDL stress has been linked to bone necrosis [28]. Even though the present investigation found that VMS at the abutment varied with the material used, both the stress

distribution and the peak VMS recorded in the PDL for the CoCr RPD (0.003 MPa) and the PEEK RPD (0.002 MPa) were similar and notably low, corroborating a preceding study (CoCr RPD 0). A link between excessive denture-bearing mucosal stress and the experience of soreness among prosthesis wearers has been established [29], wherein the pain threshold of the mucosa is estimated at around 0.63 MPa, advising caution when employing a flexible material for the free-end saddle [30]. In the present work, mucosal stress levels measured for both PEEK and CoCr (0.353-0.442 MPa) were below the 0.63 MPa mucosal pain threshold. These findings indicate that, within the tested loading scenario, neither the PEEK nor the CoCr RPD is likely to cause significant damage to the residual mucosa.

In contrast to the stress patterns that the PEEK and CoCr RPDs imposed on the oral structures, the peak VMS registered inside the CoCr RPD framework (107.99 MPa) exceeded that inside the PEEK RPD framework (11.7 MPa) by roughly a factor of nine. Simultaneously, the extent of displacement measured for the PEEK RPD framework (0.0128 mm) outstripped that measured for the CoCr RPD framework (0.0082 mm) along the vertical axis (Z-axis), an outcome that corresponds with earlier published work (CoCr RPD  $375.48 \pm 39.31$  MPa vs. PEEK RPD  $99.54 \pm 16.98$  MPa) [20]. A stiffer framework tends to amass greater internal stress while undergoing less deformation under load, a behavior consistent with the tenets of material mechanics. This response is predominantly dictated by the Young's modulus of the material, a parameter that describes stiffness, in other words, the capacity to resist elastic strain. CoCr possesses a Young's modulus (235 GPa) that is far in excess of that of PEEK (4.1 GPa), signifying that CoCr is considerably more rigid. Consequently, the CoCr RPD framework experiences only slight elastic distortion yet is prone to concentrating stress within narrow, localized zones.

On the other hand, the reduced stiffness of PEEK permits greater pliability, leading to a more widely spread deformation pattern under equivalent loading conditions. To offset this heightened compliance and preserve serviceable mechanical function, the PEEK framework should be produced with an augmented cross-sectional thickness—potentially up to twice that of the CoCr framework—to attain comparable load-carrying capacity and structural soundness. Since the pliability of the framework can influence how forces are transmitted and partitioned to the oral structures, this investigation found that less stress accumulated within the PEEK RPD framework and more was

dispersed to the underlying residual mucosa. These results match those of prior research [31, 32]. Kumar *et al.* [31] documented that a polyacetyl-based flexible RPD distributed higher stress into the ridge than a cast metal RPD, and Malhotra *et al.* [32] reported that the greatest stress was transmitted from a flexible denture base resin to the edentulous ridge. That said, a clinical investigation by Lo Russo *et al.* [33] found no meaningful short-term divergence in residual ridge height between individuals wearing a PEEK RPD and a prosthesis-free control group over a one-year observation period. Accordingly, additional clinical inquiry is warranted to probe the long-term effects of PEEK RPDs on oral tissues.

The results of the present work indicated that the PEEK RPD delivered reduced stress to both the abutment and the PDL, suggesting a possible benefit for patients with weakened periodontal support. Even so, the PEEK RPD could prove less well-suited to scenarios with extensive free-end edentulism (Kennedy Class I or II) due to elevated mucosal stress and prosthesis displacement, factors that might undermine long-term stability. As it stands, long-term clinical data remain sparse, underscoring the need for continued research before definitive clinical guidelines can be formulated. The debonding of prosthetic teeth remains a clinical challenge in RPDs, particularly with PEEK frameworks, owing to their chemically inert surfaces. Preparative treatments—for instance, etching with sulfuric acid, sandblasting, and tribochemical silica coating—have been shown to improve adhesion to acrylic resins [34, 35], and bonding agents incorporating MMA or PETIA can further strengthen the union [36]. Nevertheless, the PEEK–acrylic bond interface remains weaker than the acrylic–acrylic bond, and the paucity of long-term clinical observations underscores the need for further studies to refine surface conditioning protocols and extend the service life of the prosthesis.

That said, this study has several limitations. A linear FEA model was adopted, assuming each material to be isotropic, homogeneous, and linearly elastic to render the computational analysis more tractable. These suppositions entail that properties are uniform in every direction and that a direct proportional relationship exists between stress and strain, neither of which faithfully captures the nonlinear, viscoelastic, and anisotropic character of oral soft tissues such as the PDL and mucosa. In fact, these biological tissues exhibit nonlinear compressive responses that vary with loading magnitude and may involve time-dependent strain behavior. While a nonlinear FEA approach could represent such characteristics with greater fidelity, it

requires considerably more intricate modeling and greater computational expense [24].

The natural spread of material properties and its bearing on finite element simulation outputs is of fundamental significance. The scientific logic behind reporting value ranges to capture this variability is fully endorsed. Yet, the chief aim of the present study was to establish a clear-cut comparative baseline between a traditional material (CoCr) and an innovative substitute (PEEK) under strictly standardized, uniform conditions. To accomplish this, a deterministic FEA methodology was chosen, adopting a single representative quantity for each material input, inclusive of the Young's modulus. This methodological decision was taken to isolate the material-dependent influences on the biomechanical performance of the RPDs. While this simplification does not fully reproduce the intricacy of real-world clinical circumstances, it does permit a straightforward, unequivocal side-by-side comparison of behavioral tendencies between the two materials. It is recognized that fluctuations in the Young's modulus would yield a spectrum of stress outcomes. The Young's modulus value for CoCr reported in this study [20] was above the range reported in other sources [37]; nevertheless, the core trend and central conclusions of the study would remain unchanged. The fact that the modulus of PEEK is orders of magnitude lower than that of CoCr constitutes the decisive factor underlying the observed disparities in stress distribution and deformation. Slight variations in the elastic modulus of CoCr would not reverse the fact that it remains drastically stiffer than PEEK. Hence, the overarching trend—indicating that the PEEK RPD engenders reduced stress on abutment teeth while undergoing greater deformation—remains valid. Prospective studies that employ probabilistic or sensitivity-driven FEA strategies are recommended to delineate the full spectrum of plausible clinical performance.

Furthermore, this investigation included only a single patient presenting with a Kennedy Class I configuration. A broader sample encompassing diverse edentulous ridge classifications ought to be explored in future work.

## Conclusion

Within the confines of this three-dimensional linear FEA, the following deductions are reached:

- The CoCr RPD imparted greater stress to the abutment relative to the PEEK RPD, which implies that the PEEK RPD could offer an enhanced safeguarding effect for the abutment tooth.

- The CoCr RPD and the PEEK RPD delivered comparable stress levels to the mucosa and the PDL, all of which resided within the respective tissue's physiological tolerance. Neither the PEEK RPD nor the CoCr RPD appeared prone to inflicting serious mechanical injury upon the mucosa or the PDL.
- The rigidity of the RPD framework was tied to both the stress distribution and the deformation arising within the framework itself. The stiff CoCr RPD generated greater internal framework stress and less deformation than PEEK, which displayed greater flexibility. For this reason, the cross-sectional thickness of the PEEK framework merits careful deliberation.

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**Ethics Statement:** None

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