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Clinical Evaluation of Retention, Stability, Esthetics, Occlusion, and Tissue Response of Acrylic, Flexible, and Cobalt-Chromium Removable Partial Dentures

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ABSTRACT

Background: For patients who are partially edentulous, removable partial dentures RPDs are a crucial therapy option. Prosthesis material, retention, stability, occlusion, esthetics, and interaction with supporting oral tissues all have an impact on their clinical performance.

Objective: To compare and clinically assess the retention, stability, esthetics, occlusion, and tissue response of acrylic resin, flexible thermoplastic, and cobalt-chromium RPDs.

Materials and Methods: Thirty-seven acrylic resin, thirteen flexible thermoplastics and ten cobalt-chromium RPDs were among the sixty patients who received clinical examinations.

Retention and stability were graded as good, fair, or poor; esthetics and occlusion as acceptable or unacceptable; and tissue response as favorable or unfavorable. Frequencies and percentages were calculated. Comparisons among groups were performed using exact Monte Carlo testing based on the Pearson Chi-square statistic, with significance set at $P < 0.05$.

Results: 43.2% of acrylic, 76.9% of flexible, and 90.0% of cobalt-chromium RPDs showed good retention; with a significant difference ($P = 0.043$).

Good stability was recorded in 40.5%, 76.9%, and 90.0%, respectively with a significant difference ($P = 0.027$).

Acceptable esthetics occurred in 83.8%, 92.3%, and 90.0% with a non-significant difference ($P = 0.778$).

Acceptable occlusion occurred in 64.9%, 76.9%, and 90.0% with a non-significant difference ($P = 0.284$).

Favorable tissue response was observed in 51.4%, 76.9%, and 90.0%, respectively with a significant difference ($P = 0.043$).

Conclusion: Cobalt-chromium RPDs demonstrated the best favorable overall clinical performance particularly for retention, stability, and tissue response. Flexible RPDs also showed favorable results, whereas acrylic RPDs exhibited fewer favorable findings. Esthetic and occlusal differences were not statistically significant.

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INTRODUCTION

Mastication, speech, appearance, and quality of life can all be significantly impacted by partial edentulism, which is still a significant oral health issue. Severe tooth loss can impair oral health and psychological well-being and is still a significant global problem [1].

In older adults, tooth loss is especially important since diminished dental function can have detrimental effects on overall health, social interaction, and nutrition [2].

Patients who are partially edentulous have access to a variety of treatment options. These consist of removable partial dentures, implant-supported restorations, and fixed dental prostheses.
Removable partial dentures continue to play a crucial role in prosthodontic practice because they offer many patients a conservative and relatively affordable treatment option, even though implant-supported rehabilitation offers significant advantages in certain situations [3].

Treatment planning is heavily influenced by the pattern of partial edentulism and the location of the remaining teeth. Kennedy classification is still clinically relevant for figuring out what kind of support is available for a removable prosthesis and when tooth-supported or tooth-tissue-supported designs are needed [4].

Additionally, choosing an RPD over a fixed or implant-supported treatment may be influenced by factors such as cost, patient desire, anatomical constraints, systemic health, and treatment complexity [5].

More is needed for RPD treatment to be successful than just replacing lost teeth. In order to be considered clinically suitable, a prosthesis must be able to withstand displacement during function, retain stability under occlusal loading, maintain proper relationships with the opposing dentition, have an acceptable appearance, and protect the remaining teeth and supporting tissues.
Retention and stability continue to be significant factors in determining prosthetic function and continuous use, according to long-term clinical investigations with cobalt-chromium RPDs [6].

Framework rigidity, clasp configuration, guiding planes, rests, indirect retention, denture base adaptability, and the anatomical shape of the residual ridge are some of the variables that affect these characteristics.

Because of their affordability, ease of repair or modification, and relatively straightforward laboratory techniques, acrylic resin RPDs are frequently manufactured. When additional tooth loss happens, it is relatively simple to add artificial teeth. However, acrylic RPDs may not offer the same level of rigidity as cast-metal frameworks since they usually rely mostly on mucosal support and simple retainers. Therefore, acrylic partial dentures are sometimes thought to be especially suitable as temporary or transitional prostheses, while they may also be used for longer lengths of time in certain patients [7].
As an alternative to traditional acrylic and metal prostheses, flexible RPDs have been produced. These dentures are often made of materials based on nylon or thermoplastic polyamide. Deeper undercuts can be engaged due to their flexibility, and tissue-colored retentive components could look better when traditional metal clasps are visible [8].

As a result, flexible denture-base materials have grown in popularity, especially when patients have high esthetic standards or when anatomical undercuts make it difficult to place a rigid prosthesis. However, flexible materials behave differently mechanically than traditional rigid frames. Therefore, their benefits must be weighed against the significance of prosthesis movement control, reciprocation, and support [9].
Flexible prostheses can yield positive clinical outcomes in certain partially edentulous patients, according to clinical examination of flexible and traditional RPDs [10]. The usage of nylon-based components to lessen the visibility of retentive features has also been regarded as having esthetic benefits [11].

Cobalt-chromium frameworks differ significantly from both acrylic and flexible prostheses. Major connectors and other framework elements can withstand strain while staying relatively thin because of the stiffness of cobalt-chromium. Rests, guide plates, direct retainers, reciprocal components, and indirect retainers can all be integrated into a single rigid structure using well-designed cast frameworks. This makes it possible to more efficiently distribute functional forces across the remaining teeth and supporting tissues.
One of an RPD's main requirement is retention. In a clinical setting, retention refers to the prosthesis's resistance to moving away from its supporting elements during removal. Loss of retention may decrease the prosthesis's functional efficacy and result in movement during speech and chewing.

Clasp flexibility, undercut depth, insertion path, friction between guiding surfaces, framework precision, and denture base adaption all influence retention. As a result, different RPD materials may exhibit distinct clinical retentive tendencies.

Resistance to rotational, lateral, or horizontal displacement under functional loads is referred to as stability. When pressure is applied to various prosthetic components, a stable RPD should show very little movement. Because the supporting mucosa is more compressible than the periodontal ligament around abutment teeth, this characteristic is especially crucial in distal-extension scenarios.

Movement of the denture base can cause discomfort, disrupt occlusal connections, and increase stresses on the oral tissues when an RPD is not stable enough. Thus, properly positioned rests and rigid cross-arch stabilization may offer significant benefits.

The relationship between RPDs and periodontal health has also received considerable attention. The state of abutment teeth and plaque formation may be impacted by the presence of a removable prosthesis. However, if the prosthesis is well-designed and correct oral hygiene and maintenance are given, negative periodontal effects are not unavoidable [12].

Previous studies also highlighted the significance of adequate RPD design, routine maintenance, and plaque reduction in safeguarding periodontal tissues [13]. Therefore, significant clinical information about prosthesis adaptation, extension, movement, and distribution of functional forces can be obtained from tissue reaction under an RPD.

Another crucial element of RPD treatment is esthetics. Deterioration of prosthetic components, mismatched denture-base color, visible clasp arms, and improper artificial tooth arrangement can all negatively impact look. Cast-metal designs can frequently reduce visible components via careful planning, while flexible materials may provide an advantage by using tissue-colored retentive components.

Occlusion is also closely related to prosthesis stability. An RPD may be displaced during closure and mastication due to premature contacts or insufficient prosthetic tooth contacts. Long-term research shows that the clinical lifetime of removable dentures is influenced by prosthetic design, maintenance needs, and technical issues.

Acrylic and metal-based RPDs differ from one another, according to recent long-term survival data. Compared to acrylic resin RPDs, metal-based prostheses showed a longer median survival, suggesting that framework and material design may affect long-term clinical performance [15].

Many clinical investigations have concentrated on the overall experience of RPD wearers. Subjective results may not always clearly distinguish between different materials, as systematic evidence comparing metal and acrylic RPDs has shown [16]. This suggests that objectively verifiable clinical characteristics and perceived therapeutic success are not the same.

Clinical studies have also investigated satisfaction with RPD treatment [17], continued prosthesis use [18], long-term survival and retreatment [19], and prosthetic complications following delivery [20]. These studies collectively demonstrate that RPD success is multifactorial and should be evaluated using several clinical parameters.

Thus, the goal of this study was to directly examine the clinical performance of removable partial dentures made of acrylic, flexible thermoplastic material, and cobalt-chromium alloy in terms of retention, stability, esthetics, occlusion, and supporting tissue response.

The null hypothesis was that there would be no statistically significant association between the type of removable partial denture and any of the investigated clinical parameters.

MATERIALS AND METHODS

Study Design

A clinical observational comparative study was conducted on patients wearing removable partial dentures at the College of Dentistry, University of Kufa, and selected dental clinics in Najaf, Iraq.

A total of 60 removable partial dentures were examined. Every prosthesis had been provided within the previous year and was regularly used in clinical settings at the time of examination.

The dentures were categorized into three classes based on the prosthesis's construction and material:

Group A: 37 acrylic removable partial dentures.

Group F: 13 flexible removable partial dentures.

Group M: 10 cobalt-chromium removable partial dentures.

The prosthesis was evaluated clinically both intraorally and extra orally as needed. The examined parameters were retention, stability, esthetics, occlusion, and response of the supporting oral tissues.

The same predefined clinical criteria were applied to all three groups.

Retention Assessment:

Each prosthesis was inserted completely into its intended intraoral position. Proper seating was confirmed clinically. Next, a controlled dislodging force was applied in the direction of removal by the examiner. The prosthesis's resistance to displacement was noted.

Retention was classified as:

Good: The prosthesis needed specific, intentional force to be removed because it resisted displacement.

Fair: The prosthesis could be removed with comparatively little force, but there was moderate resistance to displacement.

Poor: The prosthesis was easily dislodged from its supporting structures and showed little resistance.

The evaluation's goal was to determine how well the retentive elements worked and how well the prosthesis adapted overall during clinical use.

Stability Assessment:

The prosthesis was fully seated when stability was assessed. Different parts of the RPD were subjected to alternating regulated finger pressure.

The right and left sides of the posterior regions were alternately compressed. When appropriate, anterior-posterior movement was also assessed.

Stability was classified as:

Good: No lateral movement, rotation, or rocking that is clinically noticeable.

Fair: The prosthesis mostly stayed in its seated position, but there was slight noticeable movement.

Poor: When pressure was applied, there was obviously noticeable rocking, rotating movement, or lateral displacement.

Esthetic Assessment:

Each prosthesis's aesthetic appeal was assessed in the oral cavity with sufficient lighting.

The examiner considered: The way artificial teeth look and are arranged; harmony between the surrounding tissues and the denture foundation; retentive component visibility; observable discoloration or degradation; integration of the prosthesis with the natural teeth that are still present.

Esthetics was noted as:

Acceptable: No significant clinically noticeable esthetic deficiency was found.

Unacceptable: One or more obvious prosthetic features adversely affected the appearance of the restoration.

Occlusal Assessment:

After the RPD was fully seated, occlusal relationships were evaluated.

The patient was instructed to close into habitual maximum intercuspation. Clinical evaluations were conducted on prosthetic tooth contacts and potential premature contacts.

Occlusion was classified as:

Acceptable: The prosthesis was neither clinically detectably displaced during closure, nor were there any apparent premature contacts.

Unacceptable: Marked absence of intended contacts, premature contact, or displacement of the prosthesis during closure was detected.

Evaluation of Supporting Oral Tissues:

The RPD was removed after the functional examination, and the supporting mucosa was closely examined.

The tissue next to the main prosthetic elements and beneath the denture base was evaluated by the examiner.

Tissue response was classified as:

Favorable: A healthy clinical appearance free of visible localized erythema, inflammation, traumatic ulceration, or prosthesis-related mucosal damage.

Unfavorable: Localized erythema, inflammation, ulceration, or traumatic mucosal alteration that is clinically linked to the RPD.

Statistical Analysis:

Data were arranged according to the type of RPD and each clinical outcome. Frequencies and percentages were calculated for descriptive analysis.

Because several contingency-table cells contained small expected frequencies, statistical associations between RPD type and clinical outcomes were evaluated using Monte Carlo exact testing based on the Pearson Chi-square statistic.

For retention and stability, three categories were compared among the three RPD groups. For esthetics, occlusion, and tissue response, two categories were compared. Statistical significance was established at $P < 0.05$.

RESULTS

A clinical examination was conducted on sixty removable partial dentures. Acrylic RPDs represented the largest group, comprising 37 prostheses (61.7%). Flexible RPDs accounted for 13 prostheses (21.7%), while 10 prostheses (16.7%) were cobalt-chromium RPDs.

Retention

The distribution of retention scores differed among the three RPD groups.

Table 1. Retention according to RPD type

RPD type	Good	Fair	Poor	Total
Acrylic	16 (43.2%)	12 (32.4%)	9 (24.4%)	37
Flexible	10 (76.9%)	2 (15.4%)	1 (7.7%)	13
Co-Cr	9 (90.0%)	1 (10.0%)	0 (0%)	10

Pearson $\chi^2 = 9.73$; Monte Carlo $P = 0.043$.

Cobalt-chromium RPDs showed the highest frequency of good retention, followed by flexible RPDs. The acrylic group likewise had the largest percentage of poor retention, with less than half of the acrylic RPDs exhibiting acceptable retention.
There was a statistically significant association between RPD type and retention.

Stability

Table 2. Stability according to RPD type

RPD type	Good	Fair	Poor	Total
Acrylic	15 (40.5%)	13 (35.1 %)	9 (24.4%)	37
Flexible	10 (76.9%)	2 (15.4%)	1 (7.7%)	13
Co-Cr	9 (90.0%)	1 (10.0%)	0 (0%)	10

Pearson $\chi^2 = 10.85$; Monte Carlo P = 0.027.

The highest frequency of good stability was shown by cobalt-chromium RPDs. Acrylic prosthesis had the highest percentage of fair and poor grades, but flexible RPDs also displayed favorable stability.
The association between RPD type and clinical stability was statistically significant.

Esthetics

Table 3. Esthetic evaluation according to RPD type

RPD type	Acceptable	Unacceptable	Total
Acrylic	31 (83.8%)	6 (16.2%)	37
Flexible	12 (92.3 %)	1 (7.7%)	13
Co-Cr	9 (90.0%)	1 (10.0%)	10

Pearson $\chi^2 = 0.72$; Monte Carlo P = 0.778.

A significant percentage of all three groups exhibited acceptable esthetics. Despite the little numerical discrepancies, flexible RPDs had the highest proportion of acceptable esthetics.
No statistically significant association was found between RPD type and esthetic classification.

Occlusion

Table 4. Occlusal evaluation according to RPD type

RPD type	Acceptable	Unacceptable	Total
Acrylic	24 (64.9%)	13 (35.1%)	37
Flexible	10 (76.9 %)	3 (23.1%)	13
Co-Cr	9 (90.0%)	1 (10.0%)	10

Pearson $\chi^2 = 2.68$; Monte Carlo P = 0.284.

Cobalt-chromium RPDs demonstrated the highest proportion of acceptable occlusion, followed by flexible and acrylic prostheses. Despite this numerical tendency, the association between RPD type and occlusion was not statistically significant.

Supporting Tissue Response

Table 5. Supporting tissue response according to RPD type

RPD type	Favorable	Unfavorable	Total
Acrylic	19 (51.4%)	18 (48.6%)	37
Flexible	10 (76.9 %)	3 (23.1%)	13
Co-Cr	9 (90.0%)	1 (10.0%)	10

Pearson $\chi^2 = 6.38$; Monte Carlo P = 0.043

Only 51.4% of acrylic RPDs showed good tissue findings, compared to 90% of cobalt-chromium prostheses and roughly 75% of flexible RPDs.
Supporting tissue reaction and RPD type were statistically significantly correlated.

DISCUSSION

Acrylic, flexible, and cobalt-chromium removable partial dentures were clinically compared in this study based on retention, stability, esthetics, occlusion, and supporting tissue response.

The findings showed statistically significant variations in retention, stability, and tissue response amongst the three RPD groups. On the other hand, variations in esthetics and occlusion were not statistically significant.

The null hypothesis was therefore partially rejected.

The type of RPD was significantly correlated with retention. In contrast to 43.2% of acrylic RPDs, 90% of cobalt-chromium prostheses and 76.9% of flexible prostheses showed good retention.

The rigid framework and its capacity to incorporate direct retainers, guide planes, rests, and reciprocal components provide a biomechanical explanation for the higher performance of cobalt-chromium RPDs. These characteristics enhance resistance to displacement and allow for controlled engagement of tooth undercuts.

Yeung et al. [6] reported clinically acceptable retention and stability among numerous cobalt-chromium RPDs several years after insertion, indicating that a well-designed cast framework can preserve functional efficacy throughout long-term service.

Additionally, flexible prosthesis showed good retention. Undercuts that could be challenging to employ with stiff materials can be engaged by their thermoplastic retentive components [8,9]. This feature could account for the roughly 75% of flexible RPDs that showed strong retention in the current assessment.

In certain partially edentulous individuals, Hundal and Madan [10] found that flexible prosthesis had better clinical results than traditional RPDs. However, it is important to distinguish between the hard mechanical control offered by a cast structure and flexible retention.

The majority of low retention ratings were found in acrylic RPDs. This result could be the result of multiple factors. Acrylic prostheses may be more prone to fit alterations over time since they frequently rely on wrought-wire clasps and denture-base adaption for retention.

Wilson [7] noted that rather than being seen as technically similar to cast frameworks in every clinical scenario, acrylic partial dentures are often best suited as temporary or transitional prosthesis.

Stability also varies significantly among the groups. Only 40.5% of acrylic RPDs, 76.9% of flexible RPDs, and 90% of cobalt-chromium RPDs showed good stability.

This outcome could be explained by the stiffness of cobalt-chromium. While appropriately positioned supports and guide planes aid in preventing vertical, lateral, and rotational movement, a stiff major connector can offer cross-arch stabilization.

One possible explanation for the comparatively low percentage of satisfactory stability among acrylic prosthesis is their increased reliance on mucosal support. Under functional loading, distal-extension acrylic bases can spin around abutment teeth due to variations in the displacement of the supporting mucosa and periodontal ligament.

In the current investigation, flexible prosthesis showed comparatively good clinical stability. The tight adaptation of the flexible base and the engagement of anatomical undercuts may be partially responsible for this outcome. Nevertheless, a cast structure offers a greater degree of cross-arch rigidity than flexibility alone. Thus, case selection is still crucial.

Esthetic outcomes showed no statistically significant differences among the three groups. More than 80% of the prostheses in every group were classified as clinically acceptable.

At 92.3%, flexible RPDs showed the highest percentage of acceptable esthetics. This result is in line with one of the main benefits of thermoplastic materials that have been suggested: the capacity to minimize visible metallic clasps and provide tissue-colored retentive components [8–11].

However, 90% of cobalt-chromium RPDs were also deemed to be esthetically pleasing. This finding shows that metal frames don't always have a bad appearance. Visible metallic components can be significantly reduced with proper positioning of direct retainers, careful clasp design, and consideration of the patient's smile line.

Similarly, the majority of acrylic prostheses were deemed esthetically pleasing. Therefore, an RPD's look depends on more than just the framework content. The final appearance can be influenced by denture-base shape, retentive component placement, artificial tooth shade and arrangement, and laboratory manufacturing quality.

Occlusion also showed no statistically significant association with the type of RPD. Although acceptable occlusion increased numerically from acrylic to flexible and cobalt-chromium prostheses, the difference did not reach the 0.05 level of significance.

Acceptable occlusion was found in 90% of cobalt-chromium RPDs compared with 76.9% of flexible and 64.9% of acrylic prostheses.

Superior stability during mandibular closure may be the reason for the comparatively positive outcomes for cobalt-chromium. The intended link between artificial teeth and the opposing dentition is more likely to be maintained by a rigid and well-supported prosthesis.

However, factors other than framework material also have an impact on occlusion. Initial tooth arrangement, opposing dentition, residual ridge alterations, clinical adjustment at insertion, tooth wear, and length of prosthesis use are some of these. Therefore, it is clinically conceivable that there isn't a statistically significant difference.

The response of supporting oral tissues demonstrated a statistically significant association with RPD type. Favorable tissue conditions were recorded in 90% of cobalt-chromium RPDs compared with 76.9% of flexible and 51.4% of acrylic RPDs.

This represents an important finding because preservation of the supporting structures is a fundamental objective of removable prosthodontic treatment.

RPDs can be compatible with periodontal health if proper design, sufficient oral hygiene, and routine maintenance are given, according to Petridis and Hempton [12]. Bergman [13] also highlighted how prosthetic design and accumulation of plaque affect periodontal reactivity related to removable dentures.

Compared to an acrylic prosthesis, a well-designed cobalt-chromium framework may require less extensive coverage of oral tissues and may offer more tooth support through rests. Reducing superfluous tissue coverage can improve hygiene and potentially lessen places were food particles and plaque buildup.

Acrylic RPDs, on the other hand, typically cover larger mucosal surfaces. More coverage may make irritation more likely if it is coupled with instability or poor fit. Additionally, traumatic ulceration or localized erythema may result from repeated base displacement under functional loads.

Intermediate tissue findings were observed with flexible dentures. Although their flexible designs may still cover significant mucosal areas, their smooth thermoplastic surfaces and adaptability may help to comfort. Therefore, tissue reaction cannot be explained by material alone.

The significant differences detected in retention, stability, and tissue response suggest that the construction and biomechanical design of an RPD can influence its objective clinical performance.

This interpretation is supported by recent data on RPD lifespan. Metal-based RPDs had a longer median survival than acrylic resin RPDs, according to Ahmed et al. [15]. Their results highlight how crucial framework design, material choice, treatment planning, and maintenance are to the long-term durability of prostheses.

Nevertheless, the current findings should not be taken to suggest that cobalt-chromium is always the best choice for every patient.

While acrylic RPDs are still helpful in transitional treatment, situations needing simple customization, and scenarios where treatment selection is influenced by cost, flexible prostheses may be beneficial when esthetics or undercut anatomy are key concerns.

Clinical performance is complex by nature. The success of an RPD is influenced by a number of factors, including the type of partial edentulism, the number and distribution of remaining teeth, periodontal health, residual ridge anatomy, occlusal relationships, impression quality, framework design, laboratory methods, and maintenance.

Removable partial dentures may eventually need to be adjusted, repaired, or replaced, according to long-term studies [14,19]. Clinical circumstances and prosthesis design also affect post-delivery complications [20].

The difference between an individual's perception of prosthetic treatment and objective clinical quality is another crucial factor to take into account. According to Almufleh et al. [16], patient-reported outcomes did not always reflect the differences between acrylic and metal RPDs. Shala et al. [17] have showed that a variety of factors affect how RPD treatment is perceived.

As a result, not every patient will have the same overall experience with a prosthesis that has clinically high retention and stability. On the other hand, a person may continue to use a prosthetic in spite of obvious technological flaws. Akeel [18] showed that a number of clinical and individual factors affect the usage of RPD after delivery.

Specifically, objective clinical characteristics were the focus of this study. The examiner can determine if problems predominantly affect retention, stability, occlusion, appearance, or the oral tissues by evaluating each measure independently.

The present study has some limitations, including the unequal distribution of prosthesis types and the potential influence of examiner judgment.

Future studies with more balanced groups and larger samples are recommended.

Within these limitations, cobalt-chromium RPDs showed the most favorable clinical performance, followed by flexible and acrylic RPDs.

CONCLUSION

Cobalt-chromium RPDs demonstrated the most favorable clinical performance, with significantly better retention, stability, and tissue response, followed by flexible and acrylic RPDs. No statistically significant differences were observed among the three groups regarding esthetics and occlusion. Appropriate material selection, prosthesis design, and regular maintenance remain essential for successful removable partial denture treatment.

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