International Journal of
Science, Architecture, Technology and Environment

'RPA or RPI' Concept - What is your choice? - A Review

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DOI: https://doi.org/10.63680/ijsate0525167.31

Abstract

For patients who are partially edentulous, removable partial dentures (RPDs) are an economical and biologically responsible treatment option. The RPA (Rest–Proximal Plate–Akers clasp) and RPI (Rest–Proximal Plate–I-bar clasp) concepts have been identified as biologically advantageous designs among the different clasp assemblies used in RPD design, especially in distal extension cases (Kennedy Class I and II). As stress-releasing clasp assemblies, both systems are designed to reduce damaging torquing forces on abutment teeth while under functional loading. A mesial occlusal rest, a guide plane on the distal surface, and a gingivally approaching I-bar clasp that disengages during occlusal loading are the main components of the RPI system, which was first put forth by Krol in the 1970s. It provides superior biomechanical benefits, better gingival health, and improved aesthetics. The RPA system is more appropriate in anatomical circumstances where I-bar placement is contraindicated because, despite having a similar structure, it substitutes a traditional circumferential clasp (Akers clasp) that wraps around the abutment tooth for the I-bar. Both RPA and RPI systems now have greater accuracy, flexibility, and patient comfort thanks to recent developments in CAD-CAM technology, digital framework design, and the use of biocompatible alloys like titanium and NiTi. Evidence-based improvement of these designs has also been aided by technologies such as laser sintering and finite element analysis (FEA). In summary, functional RPD design relies heavily on both RPA and RPI systems. But because of its superior stress-distribution properties, aesthetic appeal, and periodontal compatibility, the RPI system is widely favored and is a mainstay of modern prosthodontic practice.

Keywords: Removable Partial Dentures; Rest, Proximal Plate I bar (RPI) Concept; Rest Proximal Plate Akers Clasp (RPA) Concept; Biomechanical Principles in RPD Design

INTRODUCTION

For patients who are partially edentulous, removable partial dentures (RPDs) are intended to restore stability, function, and appearance. Two clasp designs created especially for distal-extension RPDs (Kennedy Class I and II) to reduce stress on abutment teeth and supporting tissues are the RPI (Rest, Proximal Plate, I-bar) and RPA (Rest, Proximal Plate, Akers clasp) systems. Although the goal of both systems is to regulate

biomechanical forces, their clasp mechanisms and intended clinical uses are different. **[1,2]**

RPI System

By permitting controlled movement of the prosthesis, the RPI system—first presented by Kratochvil in 1963 and then modified by Krol in 1973—is intended to reduce stress on abutment teeth in distal-extension RPDs. It is made up of three parts: **[2,3]**

Mesial Rest (R):

Function: Offers support by guiding occlusal forces along the abutment tooth's long axis. To create a fulcrum line that permits the denture base to rotate tissueward without torquing the abutment, the remainder is positioned on the mesial aspect of the abutment, away from the edentulous area.

Justification: Because the denture rotates around the rest, disengaging the I-bar from the undercut, the mesial placement lessens the leverage forces on the abutment during occlusal loading. This reduces dangerous torque.

Preparation: To prevent excessive tooth reduction in canines, a circular, concave depression is made on the mesial marginal ridge; for molars, the remainder extends into the triangular fossa.

Proximal Plate (P):

Function: Offers tissue protection, reciprocity, and stability. The plate extends slightly onto the edentulous ridge after making contact with the abutment tooth's proximal surface.

Justification: The proximal plate distributes forces to the ridge, stabilizes the abutment against lateral forces, and directs the path of insertion and removal. In order to minimize gingival coverage and plaque accumulation, Krol's modification shortened the plate's length.

Consideration: Krol's shorter, less invasive plate addressed the issue of excessive tooth contact in previous designs.

I-bar Retainer (I):

Function: A clasp that engages a tiny undercut (0.01 inch) in the gingival third of the abutment tooth, usually on the mesiobuccal aspect, as it approaches the gingiva.

Justification: Torquing forces are decreased by the I-bar's flexibility and minimal tooth contact. During tissue ward movement, it separates from the undercut, avoiding abutment stress. Its tapered shape improves appearance by hiding the metal.

Limitations: Because the approach arm of the I-bar may impinge on tissues, it is contraindicated in cases with high frenum attachments, shallow vestibules, or significant soft tissue undercuts.

Advantages of RPI

• Reduces abutment tooth stress by using a stress-breaking mechanism.
• Aesthetic because the I-bar is less noticeable and there is less metal display.
• Periodontal health is promoted by decreased gingival coverage (Krol's modification).
• When abutments have sufficient periodontal support, they work well in distal-extension situations. **[4]**
RPI drawbacks include:
• Technique-sensitive fabrication because of the exact positioning of the I-bar.
• Contraindicated in situations where there are soft tissue restrictions or undesirable tooth contours (such as extreme buccal/lingual tilts).
• Because of the design of the I-bar, it might be more difficult for patients to remove.

Kennedy Class I and II distal-extension RPDs with sufficient vestibular depth and no soft tissue undercuts are indicated.

• Adbutments with healthy periodontal health and mesiobuccal undercuts.
• Patients who value appearance over removal simplicity.

Shallow vestibules or high frenum attachments are contraindications.
Significant bulbous gingival contours or periodontal recession.

• Excessive tooth tilting or inadequate undercuts. **[5]**

RPA System:

Eliason created the RPA system in 1983 as a substitute for the RPI, but it employs a circumferential (Akers) clasp for retention rather than an I-bar. Although it addresses some of the RPI system's shortcomings, it is made for comparable distal-extension scenarios. Its constituent parts are**:[1-5]**

Mesial Rest (R):

Function: Similar to the RPI, the mesial rest provides support and establishes the fulcrum line for denture rotation. It directs forces axially and allows disengagement of the retentive arm during occlusal loading.

Rationale: The mesial rest reduces leverage on the abutment, protecting it from torquing forces.

Proximal Plate (P):

Function: The mesial rest serves as support and creates the fulcrum line for denture rotation, much like the RPI. During occlusal loading, it permits the retentive arm to disengage and directs forces axially.

Justification: By lowering the abutment's leverage, the mesial rest shields it from torquing forces.

The proximal plate (P) serves as a guide for insertion and removal as well as providing stability and reciprocation. It extends slightly onto the ridge and makes contact with the proximal surface, just like the RPI.

Justification: By distributing forces to the edentulous ridge, the plate improves stability. It is made to prevent

too much gingival coverage, much like Krol's RPI adjustment.

The Akers Clasp (A) is a circumferential clasp that engages a mesial undercut by extending around the tooth from the proximal plate. Only the retentive tip enters the undercut, and it is rigid above the height of contour while providing retention.

Justification: In situations where the I-bar is not appropriate, the Akers clasp prevents tissue impingement and is simpler to grasp for prosthesis removal. As it moves tissue ward, it separates from the undercut, lessening the abutment's stress.

The clasp may compromise aesthetics, but it is easier to fabricate and handle patients because it covers a larger portion of the tooth than the I-bar.

The circumferential clasp design of RPA makes fabrication easier and more reliable.

• Patients can remove the Akers clasp more easily because it is more accessible.
• Appropriate for situations where the I-bar is not recommended, such as bulbous gingival contours, high frenum attachments, or shallow vestibules.
• Protects abutment teeth with a stress-breaking action comparable to the RPI. **[6]**

RPA drawbacks include:

• Less appealing because the circumferential clasp exposes more metal; • More tooth structure is covered, potentially increasing plaque accumulation; • This may not be the best choice for patients with high aesthetic standards.

I-bar placement is contraindicated for distal-extension RPDs, which include those with shallow vestibules, high frenum attachments, or significant periodontal recession.

• Advertisements with mesial undercuts and adequate periodontal support.
• Patients who prioritize ease of removal over aesthetics.

The following are examples of contraindications: • Circumstances where appearance is the primary concern (maxillary anterior teeth, for instance).

• Abutments with insufficient periodontal support or improper undercuts. **[7]**

Factors Influencing Choice Between RPI and RPA

A number of clinical and patient-specific factors influence the choice between RPI and RPA, and each of these factors affects how well the RPD design works:

Abutment Tooth Alignment and Undercut Location:

RPI: Requires a mesiobuccal undercut for the I-bar. Severe buccal or lingual tilting of the abutment may contraindicate its use, as the I-bar's approach arm may not engage properly.

RPA: Also engages a mesial undercut but is more versatile with tooth alignment, as the circumferential clasp can adapt to various contours. It is preferred when the I-bar cannot be placed due to tooth angulation or undercut location.

Impact: The RPA is more adaptable to complex tooth alignments, while the RPI is ideal for well-aligned abutments with clear mesiobuccal undercuts**.[4,8]**

Soft Tissue Contours and Vestibular Depth:

RPI: Contraindicated in shallow vestibules, high frenum attachments, or significant soft tissue undercuts, as the I-bar's gingival approach may impinge on tissues, causing discomfort or tissue trauma.

RPA: The circumferential clasp avoids tissue impingement, making it suitable for cases with unfavorable soft tissue contours or limited vestibular depth.

Impact: The RPA is preferred in cases with soft tissue limitations, enhancing patient comfort and prosthesis functionality. **[8,9]**

Aesthetic Considerations:

RPI: The I-bar's minimal tooth contact and gingival approach make it more aesthetic, especially for anterior or premolar abutments where metal visibility is a concern.

RPA: The Akers clasp covers more tooth surface and is more visible, which may be unacceptable in the aesthetic zone (e.g., maxillary incisors or canines).

Impact: The RPI is favored when aesthetics is a priority, particularly in younger patients or those with high smile lines. **[4,10]**

Periodontal Health and Gingival Coverage:

RPI: Krol's modification reduces gingival coverage, minimizing plaque accumulation and promoting periodontal health. However, improper I-bar placement can still irritate tissues.

RPA: The circumferential clasp may increase plaque retention due to greater tooth coverage, but it avoids gingival impingement, potentially benefiting periodontal health in specific cases.

Impact: Both systems can maintain periodontal health with proper design and patient hygiene, but the RPI may be slightly advantageous due to less tooth coverage. **[9]**

Ease of Fabrication and Laboratory Consistency:

RPI: The I-bar requires precise fabrication and surveying to ensure proper undercut engagement, making it technique-sensitive and potentially prone to laboratory errors.

RPA: The Akers clasp is simpler to fabricate and standardize, leading to more consistent laboratory outcomes.

Impact: The RPA is preferred in settings where laboratory expertise or resources are limited.

Patient Handling and Comfort: [2,3]

RPI: The I-bar may be less intuitive for patients to grasp during removal, potentially leading to improper handling or clasp distortion.

RPA: The circumferential clasp is easier to manipulate, improving patient compliance and reducing the risk of damage during insertion/removal.

Impact: The RPA is better for patients with dexterity issues or those unfamiliar with RPD use.

Biomechanical Stress Distribution: [1,2,4]

RPI: The I-bar's flexibility and disengagement during occlusal loading effectively reduce torquing forces on the abutment, supported by finite element analysis (FEA) studies showing lower stress concentrations in flexible clasp designs.

RPA: The Akers clasp provides similar stress-breaking action but may transmit slightly higher stresses due to its rigidity above the height of contour. However, FEA studies confirm its efficacy in minimizing abutment stress when properly designed.

Impact: Both systems are biomechanically sound, but the RPI may offer a slight advantage in stress reduction for abutments with good periodontal support.

Cost and Material Considerations: [7]

RPI: Typically uses cast chromium-cobalt alloy, though wrought wire I-bars (e.g., PGP wire) can be incorporated for added flexibility. Material costs are similar to RPA.

RPA: Also uses cast alloys but may require less complex laboratory procedures due to the simpler clasp design.

Impact: The RPA may be more cost-effective in terms of laboratory time and resources.

***The choice between RPI and RPA depends on the clinical scenario and patient priorities. Based on the factors above, here are tailored recommendations: [1-10]**

Choose RPI When:

Aesthetics is a primary concern (e.g., maxillary anterior or premolar abutments).

The abutment has a clear mesiobuccal undercut and good periodontal health.

Vestibular depth is adequate, and there are no soft tissue undercuts or high frenum attachments.

The patient has good oral hygiene and can maintain the prosthesis to minimize plaque accumulation.

Rationale: The RPI's I-bar offers superior aesthetics and reduced gingival coverage, making it ideal for visible areas and periodontally stable abutments. Its stress-breaking action is highly effective in distal-extension cases.

Choose RPA When:

Soft tissue limitations (e.g., shallow vestibules, high frenum attachments, or bulbous gingival contours) contraindicate the I-bar.

The patient prioritizes ease of removal and handling over aesthetics.

Laboratory expertise is limited, or consistent fabrication is a priority.

Abutment tooth alignment is complex, or undercuts are not ideally positioned for an I-bar.

Rationale: The RPA's circumferential clasp is more versatile, easier to fabricate, and better suited for challenging soft tissue or tooth contours. It maintains comparable stress-breaking properties while improving patient comfort in specific scenarios.

General Recommendation: Because of its aesthetic benefits, decreased gingival coverage, and efficient stress distribution- especially when abutments are periodontally sound and soft tissue contours are favorable—the RPI system is recommended in the majority of distal-extension cases. Nonetheless, the RPA system is advised in cases where aesthetic requirements are secondary (such as mandibular posterior abutments) or when soft tissue restrictions or patient handling issues are substantial. Making an informed decision requires a comprehensive clinical evaluation, which includes assessing vestibular depth and surveying the cast for undercut location. [1-10]

From the standpoint of retention, the RPA (Rest, Proximal Plate, Akers clasp) and RPI (Rest, Proximal Plate, I-bar) systems are made to minimize stress on abutment teeth while offering sufficient retention for distal-extension removable partial dentures (RPDs). However, because of the different clasp designs (I-bar vs. Akers clasp), their retentive mechanisms vary, which affects their efficacy, patient experience, and clinical applicability.

Retention in RPI System

Mechanism:

In order to engage a small undercut (usually 0.01 inch) on the mesiobuccal aspect of the abutment tooth, the RPI system uses an I-bar clasp, a gingivally approaching retainer. The I-bar is flexible and tapers to a retentive tip, which enables it to engage the undercut during insertion and disengage during tissue ward movement of the denture base under occlusal load. The I-bar's elastic deformation as it passes over the height of contour into the undercut, creating a snap-in effect, which ensures retention.

Retention Characteristics:

1.Minimal Undercut Engagement:

By engaging a shallow undercut, the I-bar lessens the force needed to insert and remove it. As a result, the abutment tooth experiences less stress during these operations.

One benefit is that the I-bar disengages during functional loading, acting as a stress-breaker, reducing the

chance of torquing the abutment.

Drawback: In certain situations, a shallow undercut may result in less stability because it may offer less retentive force than deeper undercuts.

2.Flexibility:

The flexibility of the I-bar's wrought or cast design (such as chromium-cobalt or PGP wire) improves retention by allowing it to adjust to slight tooth movements without permanently deforming.

Benefit: Over time, flexible retention lowers the possibility of abutment damage or clasp fatigue.

Drawback: In situations where there are high occlusal forces or low patient compliance, excessive flexibility may jeopardize retention.

3.Aesthetic Advantage:

The I-bar is perfect for anterior or premolar abutments where aesthetics are important because of its gingival approach and minimal tooth contact, which minimize metal visibility.

Impact on Retention: Although patient satisfaction with appearance has no direct bearing on retention, it can enhance compliance, which in turn encourages regular prosthesis use and retention.

4.Tissue Considerations:

In order to prevent impingement, which could cause discomfort or dislodge the prosthesis, the I-bar needs sufficient vestibular depth and no soft tissue undercuts or high frenum attachments.

Cons: In unfavorable soft tissue conditions, incorrect I-bar placement or patient discomfort during insertion/removal may compromise retention.

Limitations for Retention:

Because these conditions restrict appropriate I-bar positioning, it is contraindicated in cases with shallow vestibules, high frenum attachments, or significant periodontal recession.

If not done correctly, technique-sensitive fabrication can result in uneven undercut engagement, which lowers retention.

The I-bar may be more difficult for patients to grasp, which could result in incorrect handling and clasp distortion. Over time, this could erode retention.

Retention in RPA System

Mechanism:

An Akers clasp, a circumferential clasp that engages a mesial undercut on the abutment tooth and extends from the proximal plate, is used in the RPA system. The clasp stays rigid above the height of contour, with only

the retentive tip entering the undercut (0.01–0.02 inch).

Similar to the RPI, the Akers clasp lessens the stress on the abutment by disengaging from the undercut when the denture base moves tissue-ward.

Retention Characteristics:

1.Deeper Undercut Engagement:

Because of its circumferential design, the Akers clasp can engage a slightly deeper undercut than the I-bar, potentially offering a stronger retentive force.

Benefit: Better retention in situations involving less compliant denture bases or higher occlusal demands.

Cons: If the proximal plate does not appropriately reciprocate, deeper undercut engagement could put more stress on the abutment.

2.Rigidity and Stability:

Compared to the flexible I-bar, the Akers clasp offers more stability and resistance to dislodgement because it is more rigid above the height of contour.

Benefit: Better retention in situations involving intricate occlusal forces or unfavorable abutment shapes.

Cons: If the clasp is poorly designed or the undercut is too deep, rigidity may increase the amount of stress transmitted to the abutment.

3.Ease of Handling:

Patients can grasp and manipulate the circumferential design more easily during insertion and removal, which lowers the possibility of clasp distortion and ensures steady retention over time.

Benefit: Patient-friendly designs improve adherence, which obliquely aids in long-term retention.

Cons: If abutment stability is compromised, increased tooth coverage may lead to a buildup of plaque, which could jeopardize periodontal health and retention.

4.Adaptability to Tissue Contours:

Because the Akers clasp prevents gingival impingement, it can be used in situations where the I-bar is not appropriate, such as those involving soft tissue undercuts, high frenum attachments, or shallow vestibules.

Benefit: Reliable retention in difficult soft tissue conditions is ensured by broader applicability.

Cons: In cases where aesthetics are important, increased metal visibility may lower patient satisfaction and have an impact on compliance.

Limitations for Retention:

Because of the increased tooth coverage of the Akers clasp, plaque may be retained, which could eventually weaken the support and retention of the abutment if periodontal health declines.

less aesthetically pleasing than the I-bar, which could have an indirect impact on retention by decreasing patient compliance in areas that are visible.

Inadequate reciprocation, such as a poorly designed proximal plate, can put more strain on the abutment, which may cause the tooth to loosen and jeopardize retention.

Comparison of Retention Effectiveness

To determine which system is superior from a retention perspective, we evaluate key factors:

1.Retentive Force:

RPA Advantage: Stronger retentive force is provided by the Akers clasp's capacity to engage a slightly deeper undercut (0.01–0.02 inch compared to 0.01 inch for the I-bar), especially in situations involving higher occlusal loads or less stable denture bases. Because of their wider engagement with the tooth surface, studies like those conducted by Cecconi et al. show that circumferential clasps typically provide higher retention than gingivally approaching clasps.

RPI Consideration: In situations requiring robust retention, such as patients with high masticatory forces, the I-bar's shallow undercut engagement may be less effective. However, it offers sufficient retention for the majority of distal-extension cases.

2.Adaptability to Clinical Scenarios:

RPA Advantage: The circumferential clasp of the RPA is more adaptable, allowing for a greater variety of abutment shapes and soft tissue circumstances (such as high frenum attachments or shallow vestibules). When the I-bar is not appropriate, this guarantees steady retention.

RPI Limitation: Soft tissue restrictions and exact undercut specifications limit the I-bar's efficacy, making it less applicable in complicated situations.

3.Patient Handling and Long-Term Retention:

RPA Advantage: The Akers clasp's simplicity of use improves patient adherence and lowers the possibility of clasp distortion during insertion or removal. This preserves clasp integrity, promoting long-term retention.

RPI Limitation: Patients may find the gingival approach of the I-bar less intuitive, which could result in incorrect handling and eventually decreased retention because of clasp deformation.

4.Impact on Abutment Health:

RPI Advantage: The abutment is less stressed due to the I-bar's flexibility and low undercut engagement, maintaining periodontal health and promoting long-term retention. In contrast to rigid circumferential clasps, flexible clasp designs like the I-bar produce lower stress concentrations, according to finite element analysis

studies like those by Rungsiyakull et al.

RPA Consideration: If hygiene is poor, the rigidity and increased tooth coverage of the Akers clasp may worsen periodontal support and retention by increasing plaque accumulation.

5.Aesthetic Influence on Compliance:

RPI Benefit: The I-bar's low visibility improves patient satisfaction, especially in aesthetic areas, encouraging regular prosthesis use and subtly aiding in retention.

RPA Limitation: The increased metal display of the Akers clasp may cause patients to comply less in areas that are visible, which could have an impact on retention because of sporadic use.

Superiority from a Retention Perspective

RPA is Superior for Retention in most distal-extension RPD cases due to the following reasons:

1. Stronger Retentive Force: The Akers clasp is more effective in situations with high occlusal demands or less stable denture bases because it can engage a deeper undercut than the I-bar, which results in greater retention.

2. Wider Applicability: In situations where the I-bar is not appropriate (such as shallow vestibules or high frenum attachments), the RPA's circumferential clasp ensures dependable retention by adapting to a greater variety of abutment and soft tissue conditions.

3. Patient Handling Ease: The Akers clasp's design makes it simpler to insert and remove, which lowers the possibility of clasp distortion and promotes steady retention over time.

4.Laboratory Consistency: The RPA promises more consistent fabrication and dependable undercut engagement due to its less technique-sensitive clasp design.

When RPI May Be Preferred:

The RPI's I-bar offers sufficient retention with little visibility in situations where aesthetics are important (such as anterior abutments), improving patient compliance and indirectly assisting retention.

The RPI's flexible I-bar reduces stress when abutment periodontal health is an issue, maintaining tooth stability and promoting long-term retention.

Clinical Decision-Making:

RPA provides stronger and more dependable retention across a variety of clinical scenarios, making it the ideal choice for patients with difficult soft tissue contours, intricate abutment alignments, or higher retentive needs.

If soft tissue conditions permit I-bar placement, use RPI for aesthetically sensitive cases or periodontally stable abutments where minimal stress and metal visibility are priorities.

Recent Advancements in RPI and RPA Systems [1-11]

1.Material Innovations:

Polyetheretherketone (PEEK):

Advancement: For RPD frameworks, such as RPI and RPA designs, PEEK, a high-performance polymer, has shown promise as a substitute for conventional chromium-cobalt (CoCr) alloys. PEEK's lightweight, biocompatible, and flexible qualities enable improved load distribution and less stress on the abutment teeth.

Effect on RPI/RPA: Research employing finite element analysis (FEA) shows that PEEK-based RPI assemblies lessen stress on abutments and supporting tissues by distributing loads more evenly than conventional CoCr circumferential clasps. PEEK's elasticity improves RPI systems' ability to break stress, and its usage in RPA clasps increases patient comfort because it is less rigid than CoCr.

Clinical Relevance: The RPI's already excellent aesthetics are enhanced by PEEK's aesthetic advantage (white or tooth-colored frames), which also facilitates RPA usage in prominent locations. However, because PEEK's mechanical characteristics differ from those of metal alloys, customised clasp designs are necessary to maximise retention and stability.

Flexible Nylon-Based Materials (e.g., Super Polyamide):

Advancement: Flexible materials like nylon-based Super Polyamide have been introduced for RPD frameworks, offering an alternative to rigid CoCr alloys. These materials are particularly beneficial in RPA designs, where the Akers clasp's rigidity can be mitigated to improve patient comfort.

Impact on RPI/RPA: A clinical study comparing CoCr and flexible RPDs in Kennedy Class II cases found that flexible materials improved aesthetics and patient satisfaction, with comparable biocompatibility, gingival health, and adaptability in undercut areas. However, flexible materials may require careful design to maintain adequate retention in RPI systems due to the I-bar's reliance on precise undercut engagement.

Clinical Relevance: Flexible materials are particularly advantageous for RPA systems in patients with soft tissue limitations (e.g., shallow vestibules), as they reduce tissue impingement and enhance retention in challenging anatomical conditions.

2.Digital Design and Fabrication (CAD/CAM):

AdvancementRPD fabrication, comprising RPI and RPA systems, has been transformed by computer-aided design and manufacturing (CAD/CAM) technologies. Precise surveying, clasp design, and framework manufacture through additive manufacturing (e.g., 3D printing) or milling are made possible by digital processes.

Effect on RPA/RPI:

RPI: Accurate identification of undercuts for I-bar placement is made possible by digital surveying techniques, like those in AiDENTAL, which enhance retention and lower fabrication mistakes. By reducing gingival covering and improving the RPI's stress-breaking effect, CAD/CAM guarantees uniform proximal plate and

rest designs.

RPA: By standardising manufacture through CAD/CAM, the Akers clasp's simplified design lowers variability among patients and labs. Additionally, digital workflows provide quick prototyping and modifications, which enhance fit and retention.

Clinical Relevance: Both methods' repeatability is improved by digital fabrication, especially for intricate RPI designs. Additionally, it encourages the use of more recent materials, such as PEEK, which need to be precisely milled in order to have the best biomechanical performance.

3.Implant-Assisted RPDs:

Advancement: It has been investigated whether integrating dental implants to support distal-extension RPDs can lessen abutment tooth displacement and stress. By reducing the need for clasp retention, implants positioned in the posterior edentulous ridge improve the functionality of both RPI and RPA systems.

Effect on RPA/RPI:

RPI: By stabilising the prosthesis, implants lessen the rotational movement of the denture base, reducing torquing stresses on abutments and improving the retention of the I-bar. Implant-assisted RPI designs considerably lessen the stress on abutments and residual ridges, according to FEA studies.

RPA: By eliminating the need for deep undercut engagement, implants enhance the Akers clasp of the RPA and preserve retention while protecting the abutment. Regardless of implant angulation or length, implants positioned in the first molar region are very successful because they reduce displacement.

Clinical Significance: Patients with lengthy edentulous spans, for whom conventional RPI or RPA systems may not be able to offer sufficient retention and stability, benefit most from implant-assisted RPDs.

4.Modified Clasp Designs:

Advancement: In order to maximise load distribution and retention, recent studies have investigated variations of RPI and RPA clasp designs. Examples include the hybrid RPH Clasp and Reverse RPA Clasp, which combine the advantages of both methods.

Hakkoum (2016) introduced the Reverse RPA Clasp, which reduces torquing stresses in asymmetrical denture bases by altering the RPA by positioning the Akers clasp on the distobuccal undercut.

RPH Clasp: Developed by Nazarova et al. (2012), this design provides an option in situations when placing the mesial rest is difficult by combining a horizontal retentive arm with a distal rest

Effect on RPA/RPI:

RPI: In situations where there are few undercuts, modified I-bar designs, like those that use wrought wire (such as PGP wire), improve retention by increasing flexibility and lowering stress on abutments.

RPA: By adjusting to intricate tooth contours, the Reverse RPA and related designs enhance retention and

increase the RPA's adaptability in situations where the I-bar is not recommended.

Clinical Relevance: By improving retention without sacrificing abutment health, these changes broaden the indications for both systems, especially in patients with uneven ridges or tilted abutments.

5.Biomechanical Optimization via Finite Element Analysis (FEA):

Advancement: Design enhancements have been guided by FEA studies, which have shed light on the distribution of stress in RPI and RPA systems. In order to reduce abutment stress, recent analyses concentrate on optimising major connector rigidity, clasp flexibility, and rest placement.

Effect on RPA/RPI:

RPI: FEA verifies that the I-bar is perfect for periodontally sound teeth because of its flexibility, which lowers stress concentrations in the gingival third and shoulder of the abutment. Long edentulous spans, on the other hand, increase displacement and call for modified designs or implant support.

RPA: The hardness of the Akers clasp puts stress on the clasp shoulder, although this can be lessened by inserting implants to lessen displacement or by adopting flexible materials such PEEK.

Clinical Relevance: By guaranteeing that clasps contact undercuts adequately while minimising detrimental stresses, especially in distal-extension situations, FEA-driven designs enhance retention.

6.Improved Impression Techniques:

Advancement: Recent research has improved the fit of RPD bases using the modified cast process, which increases stability and retention for both RPI and RPA systems. Using this method, the master cast is altered to more accurately depict the residual ridge's functional architecture.

Effect on RPA/RPI: By maintaining constant undercut engagement, improved denture base adaptation decreases tissueward movement and increases the efficacy of both I-bar and Akers clasps.

Clinical Significance: In tooth-tissue-supported RPDs, improved base adaptation promotes retention, especially for long-span distal extensions where rotational stresses are substantial [19].

Implications for RPI vs. RPA from a Retention Perspective

RPI Advancements: **[12-17]**

PEEK and flexible materials improve retention in circumstances where aesthetics are important by enhancing the I-bar's biomechanical and aesthetic benefits [12]. In order to address the technique sensitivity of the system and improve retention consistency, digital fabrication guarantees accurate I-bar placement [16, 17]. In long-span situations, implant-assisted designs increase the effectiveness of the RPI by reducing the need for clasp retention [3].

Retention Impact: These advancements strengthen the RPI's retention for periodontally sound abutments but do not fully address its limitations in soft tissue undercuts or shallow vestibules.

RPA Advancements:

Flexible materials and altered designs (such Reverse RPA) help the Akers clasp retain better in challenging anatomical circumstances. [5, 6].

Akers clasp manufacture is standardized by CAD/CAM fabrication, which guarantees greater retention and uniform undercut engagement in contrast to the I-bar [5, 17]. By improving the stability of the RPA, implant support lessens the need for deep undercuts and maintains the integrity of the abutment [3].

Retention Impact: Because of its ease of manufacturing and versatility, the RPA is better for retention in a wider range of clinical settings, especially when the I-bar is contraindicated due to soft tissue constraints.

Retention Superiority: The RPA system's advantage for retention is further supported by recent developments, which include improved performance with flexible materials and implants, easier fabrication with digital tools, and scalability to a variety of clinical situations. The RPI is less adaptable in difficult soft tissue or tooth shape situations, but it is still beneficial for aesthetics and periodontally stable abutments.

'Pump handle " effect in RPD design [1,2,4, 10,18,19]

In distal-extension RPDs (Kennedy Class I and II), a biomechanical phenomena known as the "pump handle" effect occurs as the prosthesis revolves around a fulcrum, putting undesired torqueing pressures on the abutment teeth. In tooth-tissue-supported RPDs, where the abutment teeth offer support and retention and the denture base rests on the compressible residual ridge, this effect is most noticeable. One important tactic to lessen this effect is the inclusion of a mesial rest in designs such as the RPI (Rest, Proximal Plate, I-bar) and RPA (Rest, Proximal Plate, Akers clasp) systems. The pump handle impact is eliminated by the mesial rest. Because soft tissues are more compressible than comparatively stiff abutment teeth, a distal-extension RPD can rotate tissue ward (towards the remnant ridge) under occlusal force, a phenomenon known as the pump handle effect.

The most distal rests on the abutment teeth usually form the fulcrum line, which serves as a pivot point. The clasp assembly puts torquing stresses on the abutment teeth when the prosthesis revolves around this fulcrum due to occlusal forces provided to the denture base (when chewing, for example). This rotation mimics the movement of a pump handle, in which the clasp arms raise or torque the abutment as the denture base slides tissue-ward, possibly freeing the tooth or causing damage to periodontal structures.

CONCLUSION

Two biologically orientated, stress-releasing clasp assemblies that have greatly improved the design of detachable partial dentures with distal extension are the RPA and RPI systems. The mesial rest and proximal plate, which are fundamental components of both systems, are meant to maintain abutment health and encourage advantageous biomechanics. In most clinical situations where anatomical constraints are not present, the RPI system is the recommended option due to its higher biomechanical efficiency, minimal tooth and gingival covering, and improved aesthetics, as well as its gingivally approaching I-bar. On the other hand, where soft tissue or anatomical limitations make the use of an I-bar impractical, the RPA system provides a workable substitute that maintains functionality without sacrificing patient comfort.

Recent advancements in superior alloys, CAD-CAM fabrication, and digital design have further enhanced both systems' long-term performance and adaptability. In the end, the anatomy of each patient, their functional needs, and the objective of attaining long-term abutment preservation and prosthetic success

should all be taken into consideration when choosing between RPA and RPI.

Declaration of Conflicting Interests

The authors declare no potential conflicts of interest with respect to the research, authorship and publication of this article.

Funding

The author received no financial support for the research, authorship and publication of this article.

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