

Research Article

A Clinical Study to Assess the Pressure of the Removable Part of the Precision Attachments on the Soft Tissues in Cases of Kennedy Class II

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Abstract

This study aimed to evaluate the pressure exerted on mandibular soft tissues by the removable components of two different extracoronal precision attachment systems in distal extension cases (Kennedy Class II). A total of 10 patients presenting with bilateral mandibular edentulous areas were included. The first and second premolars were prepared as abutment teeth. A rigid attachment system (MK1) was applied on one side, while a resilient attachment system (ASC 52) was placed on the opposite side. Pressure measurements were obtained immediately after prosthesis placement and after six months of function. Small perforations were created in the removable components at both proximal and distal points. These areas were analyzed using an optical microscope connected to a digital imaging system, allowing measurements in microns. The findings indicated no statistically significant differences between proximal and distal points in both attachment systems immediately after insertion. However, after six months, significant differences were observed in the rigid attachment system (MK1), particularly at distal points. Within the limitations of this study, resilient attachment systems demonstrated a more favorable pressure distribution on soft tissues compared to rigid attachment system.

Keywords

Extracoronal Attachments, Kennedy Class II, Removable Part Pressure, Optical Microscope, Soft Tissue Pressure, Precision Attachment

1. Introduction

The management of partially edentulous patients, particularly in distal extension cases, remains a complex challenge in prosthodontics. In such cases, fixed prosthetic solutions are often not feasible due to anatomical limitations or patient-related factors.

Although implant-supported restorations represent a reliable alternative, their application may be limited by insufficient bone volume, systemic conditions, or financial considerations.

Therefore, removable partial dentures (RPDs) continue to play an essential role in prosthetic rehabilitation [1, 2].

Various treatment approaches have been described for restoring missing teeth, including conventional removable dentures, cast partial dentures, attachment-retained prostheses, telescopic systems, and implant-supported options. Among these, precision attachment-retained prostheses provide a balance between function and esthetics [3].

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Precision attachments are mechanical connectors consisting of two components: one attached to the abutment tooth or implant, and the other integrated into the prosthesis. These systems improve retention and allow controlled movement, contributing to a more favorable distribution of occlusal forces [4].

At the end of the 19th century, pioneers such as Parr, Peeso, and Chayes developed early attachment systems designed to combine the advantages of fixed and removable prostheses [5].

Extracoronary attachments, later introduced in the early 20th century, allow vertical and rotational movement, thereby reducing stress concentration on abutment teeth by transferring part of the load to the supporting tissues. [6, 7].

The few retrospective studies available show a survival rate of 83.3% for 5 years, of 67.3% up to 15 years and of 50% when extrapolated to 20 years [8, 9].

Attachments can be applied in crown and bridge restorations, removable partial denture restorations, overdenture restorations, and implant restorations. Their clinical application and treatment planning principles have been extensively described in the literature [12, 13]. Free-end saddle prostheses particularly benefit from precision attachment systems because of their favorable biomechanical characteristics [14].

The selection of an appropriate attachment system depends on several factors, including available space, functional requirements, cost, and the biomechanical behavior of the prosthesis. Attachments can generally be classified as rigid or resilient, depending on their capacity to absorb functional stresses [10].

Understanding the influence of different attachment systems on stress distribution in soft tissues is essential for improving clinical outcomes [9, 10].

Recent studies have increasingly focused on the biomechanical performance of extracoronary attachments in distal extension cases [20-23].

2. Objective and Significance of the Study

This study aimed to evaluate the pressure exerted by the removable components of extracoronary precision attachments on mandibular soft tissues and to compare the pressure distribution between proximal and distal regions in Kennedy Class II cases.

Additionally, the study sought to determine which attachment type provides a more favorable biomechanical response in situations where fixed or implant-supported treatments are not feasible.

3. Materials and Methods

3.1. Study Design and Sample

This clinical study was conducted on a total of 10 patients

presenting with mandibular Kennedy Class II edentulous areas. All patients met the inclusion criteria and provided informed consent prior to participation.

Each patient received two different extracoronary precision attachment systems: a rigid attachment system (MK1) (Figure 1) on one side and a resilient attachment system (ASC 52) (Figure 2) on the contralateral side. The first and second premolars were selected as abutment teeth in all cases.



Figure 1. MK1 rigid extracoronary attachment used in the study.



Figure 2. ASC 52 extracoronary attachment used in the study.

3.2. Inclusion Criteria

The inclusion criteria for patient selection were as follows:

- 1) Presence of unilateral distal extension edentulous area in the mandible (Kennedy Class II)
 - 2) Availability of first and second premolars as abutment teeth on both sides
 - 3) Adequate periodontal support (at least half of the root length embedded in bone)
 - 4) Opposing dentition consisting of natural teeth or fixed prostheses
 - 5) Sufficient interarch space for prosthetic rehabilitation
- Selection Conditions.

3.3. Materials

The materials and equipment used in this study included a turbine handpiece, diamond burs (Komet, Germany), silicone impression materials (Zhermack, Italy), glass ionomer cement (Ivoclar Vivadent), dental stone, nickel-chromium alloy, ceramic materials (IPS Classic, Ivoclar Vivadent), self-curing acrylic resin, and precision attachment systems (ASC 52 and MK1).

An optical microscope (Olympus CX41RF, Japan) (Figure 3) with a maximum magnification of 500× was used, connected to a digital imaging system for measurement analysis. A calibrated micrometric ruler (Figure 4) was utilized to convert pixel-based measurements into microns.



Figure 3. Optical microscope system used for image acquisition and measurement.

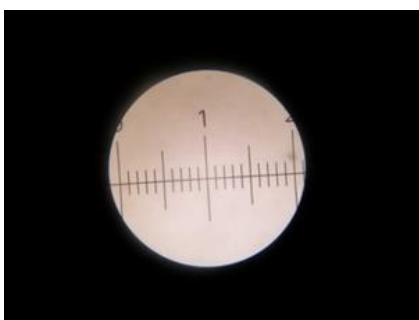


Figure 4. Calibration ruler used for microscopic measurements.

3.4. Prosthetic Procedure

The prosthetic procedure was carried out in several stages. The abutment teeth (first and second premolars) were pre-

pared to receive metal-ceramic crowns. Following tooth preparation, impressions were taken and casts were fabricated (Figure 5).



Figure 5. Preparation of abutment teeth for metal-ceramic crowns.

The female components of the attachments were incorporated into the crowns during the waxing stage and subsequently cast using a nickel-chromium alloy. After ceramic application and finishing, the crowns were clinically evaluated (Figure 6).



Figure 6. Ceramic crowns and attachment integration during crown fabrication.

A new impression was then taken with the crowns in place to obtain a working cast. The removable prosthetic components were fabricated using self-curing acrylic resin and metal framework, followed by the incorporation of artificial teeth and gingival structures (Figure 7).



Figure 7. Fabrication of the removable prosthetic component.

Finally, the prostheses were inserted intraorally, ensuring proper engagement between male and female components. Cementation was performed using glass ionomer cement (Figure 8).



Figure 8. Clinical placement of prosthesis with attachment system.

3.5. Pressure Measurement Procedure

Pressure evaluation was conducted at two time intervals:

- 1) Immediately after prosthesis insertion
- 2) After six months of clinical use

Standardized perforations (1 mm depth) were created at the proximal and distal regions of the removable components of the attachments. (Figure 9).



Figure 9. Standardized perforation created at proximal and distal points for pressure measurement.



Figure 10. Silicone impression taken under functional loading conditions.

Under functional loading conditions, silicone impressions were taken while patients were instructed to bite firmly. The resulting samples were sectioned horizontally using two parallel blades spaced 0.5 mm apart to obtain uniform microscopic sections (Figure 10).

The sections were analyzed under 100× magnification using the optical microscope. Digital images were captured and processed using specialized software (Figure 11).

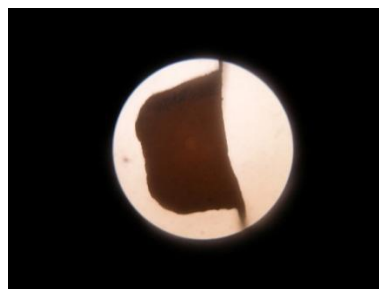


Figure 11. Microscopic section of perforation area.

A calibration process was performed using a micrometric ruler to establish the relationship between pixel measurements and real distances. Horizontal distances within the samples were measured at three standardized points and converted into microns (Figure 12).

3.6. Statistical Analysis

All data were recorded and analyzed using SPSS software (Version 22.0). Mean values were calculated for all measurements.

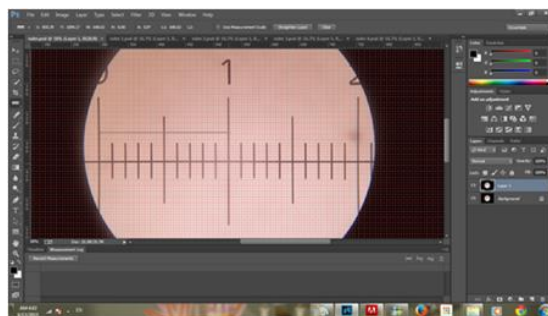


Figure 12. Calibration process for converting pixel measurements to microns.

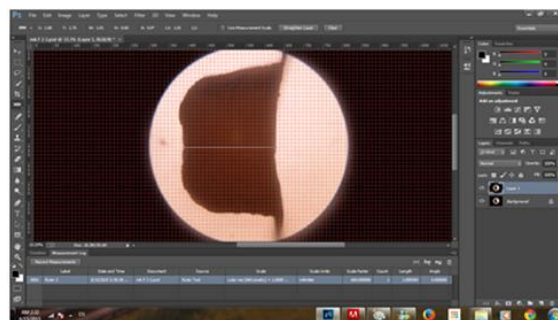


Figure 13. Digital measurement of pressure-related space using software analysis.

The Wilcoxon signed-rank test was used to compare related samples (Figure 13). Statistical significance was set at $p < 0.05$.

4. Results

Statistical analysis was performed using the Wilcoxon signed-rank test to evaluate differences between proximal and distal measurement points within each attachment system, as well as differences between the two attachment types at different time intervals.

4.1. Comparison Between Proximal and Distal Points Immediately After Insertion

No statistically significant difference was observed between proximal and distal measurement points for either attachment system (ASC 52 and MK1) immediately after prosthesis insertion ($p > 0.05$).

These findings indicate that both attachment systems demonstrated a similar pressure distribution pattern at the time of initial placement.

4.2. Comparison Between Proximal and Distal Points After Six Months

After six months of clinical use, no statistically significant difference was found between proximal and distal measurement points in the resilient attachment system (ASC 52) ($p > 0.05$).

In contrast, a statistically significant difference was observed in the rigid attachment system (MK1) between proximal and distal points ($p < 0.05$). The distal region exhibited lower measured space values, indicating increased pressure on the soft tissues.

4.3. Comparison Between Attachment Systems

No statistically significant difference was found between the two attachment systems in distal measurements immediately after prosthesis insertion ($p > 0.05$).

However, after six months, a statistically significant difference was observed between the distal measurements of the two systems ($p < 0.05$). The rigid attachment system (MK1) demonstrated higher pressure on the distal extension area compared to the resilient attachment system (ASC 52).

Overall, the results indicate that while both attachment systems perform similarly at the time of insertion, the resilient attachment system maintains a more favorable pressure distribution over time, particularly in distal regions.

5. Discussion

Distal extension cases (Kennedy Class II) present significant biomechanical challenges due to the difference in support

between natural teeth and soft tissues. This discrepancy often results in uneven stress distribution during functional loading, potentially compromising the longevity of both the prosthesis and supporting structures [11, 17].

The results of the present study demonstrated that both rigid and resilient attachment systems exhibited similar pressure distribution patterns immediately after prosthesis insertion. This finding may be attributed to the initial adaptation phase, during which functional loading has not yet significantly influenced the biomechanical behavior of the prosthesis.

However, after six months of clinical use, a statistically significant difference was observed in the rigid attachment system (MK1), particularly at distal regions. The reduced space values in these areas indicate increased pressure on the underlying soft tissues. This suggests that rigid attachments tend to transmit occlusal forces more directly to the distal extension base, leading to stress concentration over time [18, 19].

In contrast, the resilient attachment system (ASC 52) maintained a more uniform pressure distribution, with no statistically significant differences between proximal and distal regions after six months. This behavior can be explained by the design of resilient attachments, which allows controlled vertical and rotational movement, thereby acting as a stress-breaking mechanism [17, 18].

These findings are consistent with previous studies. Wang et al. reported that non-rigid extracoronal attachments significantly reduce stress concentration on supporting tissues, as demonstrated through finite element analysis [18]. Similarly, Nishimura et al. showed that semi-rigid connectors improve load transfer and reduce stress on abutment teeth and surrounding tissues compared to rigid systems [19].

From a clinical perspective, excessive pressure in distal extension areas may lead to mucosal irritation, residual ridge resorption, and patient discomfort over time [15, 16]. Therefore, the ability of resilient attachment systems to distribute functional loads more evenly represents a clear clinical advantage.

The findings of this study support the growing body of evidence suggesting that attachment flexibility plays a crucial role in stress modulation and long-term prosthetic success [17-19, 23].

However, this study has certain limitations, including the relatively small sample size and the limited follow-up period. Future studies with larger populations and longer observation periods are recommended to further validate these results and enhance their generalizability.

Despite these limitations, the present study provides valuable clinical insight into the biomechanical behavior of extracoronal attachment systems and highlights the advantages of resilient designs in distal extension cases.

6. Conclusions

Within the limitations of this clinical study, extracoronal precision attachments can be considered a reliable treatment option for the rehabilitation of mandibular Kennedy Class II cases.

The findings indicate that rigid attachment systems tend to generate higher pressure on distal soft tissues over time, whereas resilient attachment systems provide a more favorable and balanced distribution of functional loads.

From a clinical standpoint, the use of resilient attachments may contribute to improved patient comfort, reduced risk of soft tissue damage, and enhanced long-term prosthetic performance in distal extension cases.

Therefore, when biomechanical considerations are prioritized, resilient extracoronal attachment systems should be preferred over rigid designs in Kennedy Class II rehabilitations.

These findings may help clinicians select the most appropriate attachment system for distal extension cases.

Abbreviations

RPD	Removable Partial Denture
ASC 52	Resilient Extracoronal Attachment System
MK1	Rigid Extracoronal Attachment System
SPSS	Statistical Package for the Social Sciences
mm	Millimeter
µm	Micrometer

Author Contributions

Deniz Suleiman: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Visualization, Writing – original draft, Writing – review & editing

Conflicts of Interest

The author declares no conflicts of interest.

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