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Rehabilitation of a Pier Abutment Using a Custom Stress-Breaking Non-Rigid Connector in a Long-Span Fixed Partial Denture: A Clinical Case Report

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Keywords

DMLS framework; pier abutment; non-rigid connector; stress breaker; fixed partial denture; key–keyway attachment.

Abstract

Background: Rehabilitating long-span partially edentulous arches with pier abutments in fixed prosthodontics is biomechanically difficult. Rigid connectors can concentrate stresses, causing retainer debonding, porcelain fracture, and prosthesis failure due to abutment teeth mobility. Limiting prosthesis component mobility and stress transmission with a non-rigid connector reduces stress. This paper describes clinical rehabilitation of a maxillary pier abutment using a custom key-keyway non-rigid connector in a metal-ceramic fixed partial denture.

Case presentation: A 63-year-old woman came with missing teeth and had problems with mastication. Missing teeth 14, 16, 25, 26, and 27 and pier abutment tooth 15 were clinically present. A custom key–keyway non-rigid connector on the mesial pier abutment was planned for a five-unit porcelain-fused-to-metal fixed partial denture from teeth 13 to 17. A six-unit fixed partial denture from teeth 23–28 followed. Both prostheses used DMLS and Type I glass ionomer luting cement. Outcome: Prostheses had good marginal adaptation, passive adjustment, functional occlusion, and esthetics. At 1 week, 1 month, and 4 months, we found stable occlusion, healthy periodontal tissues, no retainer loosening, connector failure, or ceramic fracture. Patient mastication and satisfaction improved.

Clinical Importance: A custom non-rigid connector on the mesial side of a pier abutment reduces biomechanical stress. Clinical performance of long-span fixed partial dentures improves.

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Introduction

Pier abutments are natural teeth between two edentulous spaces and pose a major biomechanical challenge in the rehabilitation of fixed partial denture (FPD) owing to differential mobility of the supporting abutment teeth.[1,4] In long-span FPDs, the rigid connectors may cause a fulcrum effect under functional loading, leading to unfavorable stress distribution, debonding of retainers, distortion of the framework, fracture of porcelain and eventual failure of the prosthesis.[4,5] Hence, the selection of the proper connector is of utmost importance to obtain the desired stress distribution and long-term clinical success.

Non-rigid connectors allow limited independent movement of the prosthesis segments, reducing stress concentrations on the abutments. The tenon-mortise (key-keyway) design is the most frequently recommended among all available designs because it offers predictable biomechanical performance and good clinical results.[1,6,9] The position of the keyway on the mesial aspect of the pier abutment also helps in stress dissipation during function.[1]

Digital dentistry, and in particular direct metal laser sintering (DMLS), has improved the accuracy of the framework, the passive fit, and manufacturing precision compared to conventional casting techniques.[10] Case report on rehabilitation of a maxillary pier abutment with a metal-ceramic FPD fabricated by DMLS with a custom key-keyway non-rigid connector.

Case Report:

A 63-year-old female presented to the Department of Prosthodontics with the chief complaint of missing upper posterior teeth on both sides. Medical history: she has type II diabetes mellitus for 10 years, hypertension for 20 years, and hypothyroidism for 10 years and is on medication. Dental history revealed extraction of posterior teeth due to dental caries one month back and root canal treatment of multiple teeth.

On clinical examination, the patient had proclined maxillary anterior teeth with missing teeth 14, 16, 25, 26 and 27. Tooth 15 was a pier abutment. The treatment plan was constructed based on the occlusion of the patient, remaining tooth structure, periodontal condition and esthetic expectations and will include: (Fig. 1)

- Custom non-rigid connector and tooth 15 as the abutment pier of a 5-unit metal-ceramic FPD 13 to 17.
- Conventional metal-ceramic FPD from 23 to 28 - 6 units.

Figures: 1

Clinical procedure:

Impressions were made with irreversible hydrocolloid alginate (Chromatex®; DPI® Ltd., India) and poured with Type III dental stone (Goldstone®; Asian Chemicals, India). Teeth 13, 15 and 17 were prepared according to conventional principles of preparation for metal-ceramic restorations. Gingival displacement was done using Ultrapak™ gingival retraction cord (Ultradent Products Inc., South Jordan, UT, USA) (Fig. 2), and the final impression was taken with polyvinyl siloxane elastomeric impression material (Flexceed; GC India Dental Pvt. Ltd., India). The maxillomandibular relationship was recorded using Aluwax (Deepti Dental Products, Ratnagiri, Maharashtra, India), and provisional restorations were fabricated using tooth-coloured autopolymerizing acrylic resin (DPI® Ltd., India) (Fig. 3).

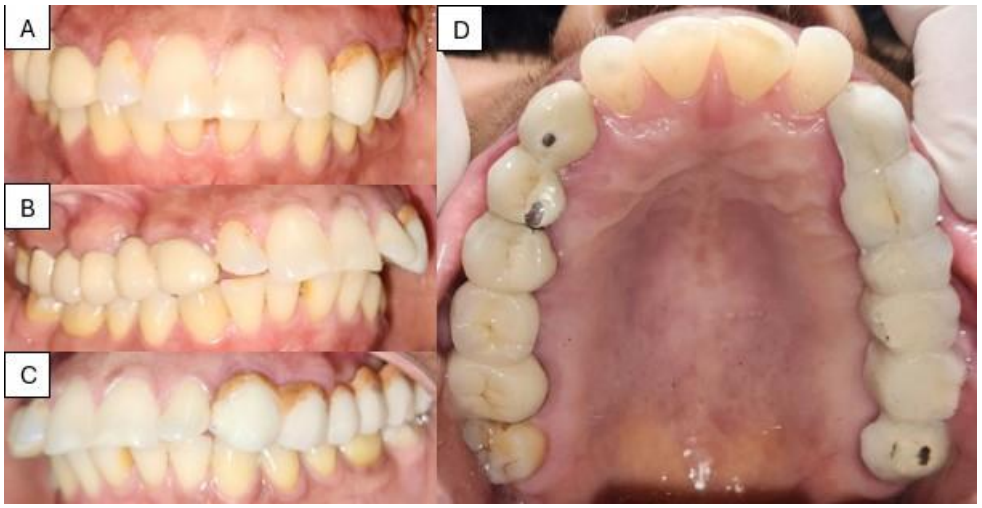
Figures: 2

Figures: 3

The definitive cast was poured using Type IV Die stone (Goldstone®; Asian Chemicals, India) and scanned to fabricate a DMLS metal framework. A custom key–keyway non-rigid connector was designed with the male component positioned on the mesial aspect of the retainer on tooth 15 and the female component incorporated into the distal aspect of the pontic replacing tooth 14. Metal framework try-in demonstrated satisfactory seating. Areas of occlusal interference were adjusted before ceramic veneering. Where occlusal clearance was inadequate, metal islands were preserved rather than excessive ceramic buildup to prevent porcelain fracture (Fig. 4).

Figures: 4

Following glazing, the definitive prosthesis was evaluated intraorally for marginal adaptation, proximal contacts, passive fit, and occlusion. Cementation was performed using Type I glass ionomer luting cement (GC Gold Label I Fuji I; GC Corporation, Tokyo, Japan). One week later, the contralateral six-unit FPD extending from teeth 23 to 28 was fabricated and cemented using the same protocol (Fig. 5).



Figures: 5

Outcome and Follow-up

The patient had good esthetics, phonetics, and masticatory efficiency after prosthesis delivery. Healthy periodontal tissues, stable occlusion, good oral hygiene, and no retainer debonding, ceramic fracture, connector failure, or patient discomfort were found at one week, one month, and four months. The patient was satisfied with the prosthesis.

Discussion

Pier abutments present a biomechanical challenge in fixed prosthodontics because rigid connectors may create a fulcrum effect, generating tensile stress at one terminal retainer and compressive forces at the opposite end, increasing the risk of cement failure, framework distortion, and ceramic fracture.[1–5] Non-rigid connectors overcome this limitation by permitting controlled movement between prosthesis segments, thereby improving stress distribution. Placement of the connector on the mesial aspect of the pier abutment further minimizes mesiodistal torquing forces during function.[3–8] Direct metal laser sintering (DMLS) has enhanced framework fabrication by providing superior dimensional accuracy, passive fit, and fewer casting defects than conventional casting methods.[9,10] Previous studies have consistently demonstrated the biomechanical advantages of non-rigid connectors. Oruc et al. [4] reported less stress concentration with non-rigid connectors, while Akulwar et al. [7] and Yadav et al.[8] found that key-keyway design reduced the fulcrum effect and improved the force distribution. Sharma et al.[6] reported clinical rehabilitation with a key–keyway connector, while Rathee et al.[9] discussed the advantages of digitally fabricated non-rigid connectors with improved passive fit. In agreement with these findings, the present case used a custom DMLS-fabricated key–keyway connector, achieving an excellent passive fit, favorable stress dissipation, and no biological or mechanical complications over a four-month follow-up.

Limitation

This report is limited by the short follow-up period. Longer follow-up clinical studies must evaluate the survival of prostheses and their mechanical behavior.

Conclusion

Custom DMLS-fabricated key–keyway non-rigid connectors represent a predictable approach to rehabilitating pier-abutment cases by improving stress distribution, minimizing biomechanical complications, and providing satisfactory short-term functional and esthetic outcomes.

Declarations:

Patient Consent

The patient gave written consent for treatment and public ation of clinical details and images. Patient identity is protected.

Conflict of Interest

The authors declare no conflict of interest.

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