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Enhancing Longevity of Fixed Partial Dentures: A Case Report of Non-Rigid Connectors in Pier Abutments

Neha Singla[1]; Ishaan Malhotra[2]; Saatvik Garg[3]; Shreya Ghosh[4]; Pankaj Datta[5]

[1,2,3,4,5]Department of Prosthodontics and crown & bridge I.T.S Dental College, Ghaziabad, India

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ABSTRACT

A pier abutment is a stable abutment tooth positioned between two edentulous spaces. A common clinical scenario involves the loss of the first premolar and first molar in either the maxillary or mandibular arch, necessitating a fixed partial denture design where the canine and second molar serve as terminal abutments, while the second premolar acts as the pier abutment. It has been suggested that during function, terminal abutments may experience intrusion, resulting in a tilting motion with the pier abutment acting as a fulcrum. These movements can ultimately lead to the debonding of the less retentive terminal retainer. To address this issue, the use of non-rigid connectors has been advocated. This clinical case report presents the application of a non-rigid connector in the rehabilitation of a pier abutment case.

Keywords: nonrigid connector, key-keyway, tenon-mortise, pier abutment

Introduction

Selecting the appropriate abutment for a fixed partial denture requires a precise and well-informed diagnostic approach. A comprehensive understanding of dental anatomy, ceramics, material science, metallurgy, phonetics, physiology, radiology, and oral mechanics is essential for effective treatment planning. Additionally, recognizing the ideal indications and inherent limitations of fixed partial denture abutments is crucial. While attempts have been made to establish objective guidelines for abutment evaluation, there are currently no universally accepted, evidence-based criteria.

One of the primary factors influencing the longevity of a tooth as an abutment for a fixed or removable prosthesis is the crown-to-root ratio (CRR). Other key factors include abutment mobility, alveolar bone support, root morphology and angulation, occlusal forces, pulp health, history of endodontic treatment, and the remaining tooth structure.

In cases where a partially edentulous arch includes a tooth positioned between two edentulous spaces, this tooth serves as a pier abutment. Using rigid connectors in fixed partial dentures with pier abutments can lead to differential stress distribution, causing anterior or posterior abutments to experience excessive forces. This results in the middle abutment acting as a fulcrum, which may lead to complications such as debonding or mechanical failure.

To address this issue, the incorporation of non-rigid connectors has been recommended. Experts have proposed various placement positions for these connectors. Some researchers advocate placing them near the pier abutment, while others emphasize their role in stress distribution between pontics and retainers. Certain fixed bridge designs utilize long-span stress-relief mechanisms supported by pier abutments to minimize unfavorable forces.

This article presents a straightforward yet innovative approach utilizing non-rigid connectors in pier abutment cases. The proposed technique offers multiple advantages, including cost-effectiveness, ease of fabrication, and minimal tooth reduction.

Case report

A 55-year-old male patient presented to the department of prosthodontics at the I.T.S Dental College in Ghaziabad with the chief complaint of missing teeth and difficulty in mastication for the past one year. Past dental history reveals the extraction of the left maxillary first premolar (24), first molar (26) and right mandibular first premolar (44), first molar (46) due to dental caries one year ago. No relevant medical history was revealed. Intraoral examination revealed missing 15, 24,26,36,37,44 and 46 with the left maxillary second premolar (25) and right mandibular second premolar (45) acting as a pier abutment (Fig. 1and Fig. 2). An evaluation of the clinical and radiographic findings revealed healthy abutments with the favourable crown to root ratio. There were three treatment options: implant-retained dental prosthesis, fixed dental prosthesis with a rigid connector, and fixed dental prosthesis with a non-rigid connector.

The patient was not willing to undergo surgical intervention, so implant- retained dental prostheses were ruled out. Finally, it was decided to rehabilitate the patient using a PFM fixed dental prosthesis with the non-rigid connector on the distal aspect of the pier abutment.

Figure. 1 Intraoral pre-operative photograph Figure. 2 Intraoral pre-operative photographs

Clinical Procedure

After obtaining written consent from the patient, maxillary left canine (23), second premolar (25) and second molar (27) also, mandibular right canine (43), second premolar (45) and second molar (47) were prepared to receive PFM crowns with shoulder finish lines and supra- gingival margins (Fig. 3 and 4) and the final impression was made digitally with intra-oral scanner for both maxillary and mandibular arch, and CAD designing (Fig. 5) and milling was done.

Figure. 3. Tooth preparation wrt 23,25,27 Figure. 4. Tooth preparation wrt 43,45,4

The metal fit was checked in the lab after both male and female portions were inserted (Fig. 7). Clinically, both the anterior and posterior segments were tried to ensure that the restoration's marginal fit was correct. Following shade selection, it was ceramized. The laboratory procedure was completed by assembling the anterior segment with the female portion (keyway mortise) and the posterior segment with the male portion (key tenon) in the working cast. In the patient's mouth, a metal try-in of the anterior attachment with key-way or mortise was done. A three- unit segment consisting of 23, 24 and 25 (pier abutment) was cemented first, followed by a two-unit posterior segment consisting of 26 and 27, with a key on the mesial contour of 26. Similarly, the pier abutment prosthesis was also cemented in mandibular arch. A 3M ESPE RelyX U200 resin cement was used for the cementation. An 50articulating paper was used to check the interferences in all centric and eccentric relation after removing the extra cement.

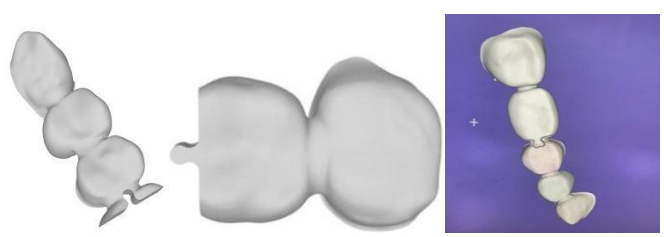

Figure. 5. CAD designing

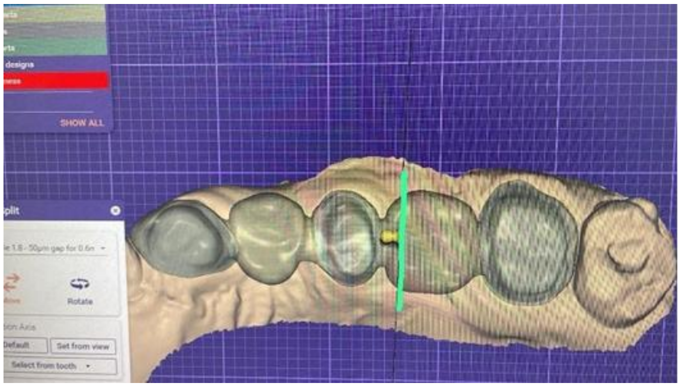

Figure. 6. Attachment of Non-Rigid Connector Figure. 7. Metal Trial

Figure. 8. Final Prosthesis

Figure. 9. Intraoral post-operative photograph

(a) (b)

(c)

Figure 10: Postoperative clinical photographs: (a) frontal view, (b) lateral view: right side, and (c) lateral view: left side.

Discussion

The weakest terminal abutments are at risk of failure due to the fulcrum-like effect exerted by the pier abutment [3]. In a stress-breaking mechanism, shear forces are redirected toward the supporting bone rather than the connector, reducing strain on the prosthesis. For this reason, stress breakers are recommended at both ends of the pier abutment. The facial-lingual movement of the first molar relative to the central incisor has an incursion value of 28 µm, with a range of 56 to 108 µm [4,5]. Additionally, the facial-lingual movement of anterior teeth occurs at a different angle than that of molars due to the curvature of the dental arch [6]. These biomechanical differences can induce stress within a long-span prosthesis, transmitting forces to the abutments [3,7,8].

The combined effects of movement distances, independent abutment mobility, and prosthetic flexion can result in stress accumulation around abutment teeth and between retainers and abutment preparations [1]. To mitigate this issue, the use of a non-rigid connector has been recommended [9]. Even with a seemingly close fit, a non-rigid connector permits sufficient movement to prevent stress transfer from the loaded segment to the rest of the fixed partial denture [8]. Stress dissipation primarily occurs within the non-rigid connector itself [3,10–13].

According to Shillingburg, the ideal placement of the keyway is on the distal aspect of the pier abutment retainer, while the key should be positioned on the mesial aspect of the distal pontic. This configuration minimizes mesiodistal movement of the abutments, allowing them to function independently. In the present case, the first premolars and first molars were missing, with the second premolars serving as the pier abutments in each arch (Fig. 6). A Tenon-Mortise (Key-Keyway) connector was utilized, featuring a dovetail keyway within the retainer and a T-shaped key attached to the pontic. Occlusal interferences were assessed and eliminated before final cementation of the prosthesis in both the maxillary and mandibular arches (Fig. 9).

A non-rigid fixed dental prosthesis (FDP) redirects shear stress to the supporting bone rather than concentrating it within the connectors. This design minimizes torque on the mesiodistal abutments while preserving their independent movement. However, over time, it may contribute to pathological movement of anterior teeth. By positioning the non-rigid connector further from the pier abutment, stress concentration at the pier is reduced. Despite the complexities involved in fabrication, incorporating non-rigid connectors in pier abutment cases enhances the long-term durability of prostheses due to their stress-relieving properties.

Conclusion

A FPD's potential success is significantly influenced by the size, form, and kind of connectors used. Choosing the right connector is a crucial stage in the pier abutment treatment design process. In addition to allowing for natural tooth movement, non-rigid connectors reduce stress transferred to abutments. A long span fixed partial denture's performance thus depends on the design and passive fit of non-rigid connectors.

Conflict of interest

None to declare.

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