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Case Report

Pier Abutment Rehabilitation Using a Five-Unit Fixed Dental Prosthesis with Bilateral Non-Rigid Connectors: A Clinical Case Report

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Abstract
Background: *Rehabilitation of a partially edentulous arch involving a pier abutment presents a biomechanical challenge because differential movement of abutments may generate unfavorable forces within a rigidly connected fixed dental prosthesis (FDP). Non-rigid connectors have been advocated to permit independent movement between prosthetic segments and reduce stress transfer.*
Case Report: *A 45-year-old female patient reported with missing right upper first premolar and first molar, with masticatory and esthetic concerns. Following endodontic treatment, the maxillary right canine, second premolar, and second molar were prepared for a five-unit porcelain-fused-to-metal FDP. A bilateral non-rigid connector design incorporating key-and-keyway (tenon-and-mortise) components on the mesial and distal aspects of the pier abutment was planned. The master cast and interocclusal record were digitized, followed by digital surveying and connector design to establish contours, parallelism, and path of insertion. The components were milled and clinically verified. The three prosthetic segments were sequentially cemented using glass ionomer luting cement.*
Conclusion: *Selection and positioning of connectors are essential in FDP rehabilitation involving pier abutments. Bilateral non-rigid connectors may permit independent movement between anterior and posterior segments. Digital planning and fabrication may facilitate accurate connector positioning and execution. Long-term follow-up is required to assess durability.*

Keywords: *Pier abutment; Fixed dental prosthesis; Key-and-keyway connector; Digital workflow; Porcelain-fused-to-metal.*

Introduction
The replacement of a missing first premolar and first molar may result in a five-unit FDP in which the canine and second molar serve as terminal abutments and the second premolar functions as a pier abutment. A pier abutment may act as a fulcrum within a rigidly connected prosthesis, potentially resulting in differential movement of the terminal abutments and unfavorable stress transfer to the abutment teeth and prosthetic components. [1,2]

Rigid connectors are mostly used as FDP; however, non-rigid connectors have been advocated in selected situations involving pier abutments. These connectors permit limited movement between prosthetic segments and may reduce unfavorable mesiodistal torque and stress concentration associated with differential movement of the abutments. [2–4] Several types of non-rigid connectors have been described, including key-and-keyway, dovetail, loop, split, and other attachment designs. [3,4]

The position of a non-rigid connector is an important consideration. A finite element analysis of five-unit FDPs with pier abutments demonstrated that connector position influenced stress distribution and reported reduced stress concentration at the pier abutment when a non-rigid connector was positioned at the distal region of the second premolar.[5] Although unilateral non-rigid connector designs are commonly described, the use of bilateral non-rigid connectors may be considered in selected clinical situations to permit limited independent movement of both prosthetic segments.

The present case describes the rehabilitation of a maxillary five-unit FDP involving a pier abutment using bilateral key-and-keyway non-rigid connectors planned and fabricated using a digitally guided workflow.

Case Presentation

A 45-year-old female patient reported to the Department of Prosthodontics, SMBT Dental College and Hospital, Ghulewadi, Sangamner, Maharashtra, India, with a chief complaint of missing teeth, difficulty in mastication, and esthetic concerns. Her medical history was non-contributory. The patient had a history of extraction of the grossly decayed right upper first premolar and first molar several months previously.

Clinical and radiographic examination revealed adequate periodontal and osseous support of the right upper canine, second premolar, and second molar, which were considered suitable as abutments. The right maxillary second premolar was identified as the pier abutment, while the canine and second molar served as the terminal abutments.

The treatment options considered included a conventional FPD with rigid connectors, an FPD incorporating a non-rigid connector on the distal aspect of the pier abutment, an FPD incorporating bilateral non-rigid connectors, and an implant-supported prosthesis. The patient declined surgical treatment; therefore, implant-supported rehabilitation was not pursued. After comprehensive evaluation and discussion of the advantages and disadvantages of the available treatment options, a five-unit FPD incorporating bilateral non-rigid connectors was selected. The patient provided written informed consent before treatment.

Clinical Procedure

Following endodontic treatment of teeth 13, 15, and 17, the abutment teeth were prepared to receive porcelain-fused-to-metal restorations. Appropriate axial and occlusal reduction was performed, and equigingival shoulder finish lines were prepared where indicated. (Table/Fig. 1 and 2; Fig. 3)

Gingival retraction was performed using a retraction cord, followed by making the definitive impression with an elastomeric impression material using a two-step putty-wash technique. An interocclusal record was obtained using a bite-registration material. Provisional restorations were fabricated using tooth-colored auto polymerizing acrylic resin and cemented with a non-eugenol temporary luting cement.

The definitive impression was poured using Type IV dental stone, and the master cast was obtained and mounted on an articulator using the interocclusal record. The master cast and interocclusal record were scanned using a Helios 3D scanner. Digital surveying was performed to determine the position, parallelism, and path of insertion of the key-and-keyway components. The tenon (key) components were digitally designed on the mesial and distal aspects of the pier abutment, while the corresponding mortise (keyway) components were incorporated into the adjacent prosthetic segments. The contours, spatial relationship, and parallelism of the components were verified digitally before fabrication. (Fig. 4–6)

The digitally designed prosthetic components were milled as three separate segments. Following milling, the components were evaluated on the master cast to verify the accuracy of the key-and-keyway relationship, parallelism, and seating. Intraoral metal try-in was subsequently performed to evaluate the fit and seating of the individual components. (Fig. 7 and 8)

After satisfactory metal try-in, shade selection was performed, followed by ceramic layering and firing. The anterior segment comprising teeth 13 and 14 incorporated the keyway, the middle segment comprising tooth 15 incorporated the key components on its mesial and distal aspects, and the posterior segment comprising teeth 16 and 17 incorporated the corresponding keyway. The three segments were assembled, and marginal fit, proximal contacts, occlusion, and connector engagement were evaluated. Occlusal adjustments were performed where necessary, followed by glazing. (Fig. 9–11)

During cementation, the middle segment containing the pier abutment was cemented first using Type I glass ionomer luting cement. After initial setting, excess cement was removed. The anterior and posterior segments were subsequently cemented sequentially, ensuring complete seating and engagement of the corresponding key-and-keyway components. (Fig. 12)

The patient received oral hygiene instructions, including the use of dental floss and an interdental brush. Follow-up examinations were performed at 1 week, 1 month, 3 months, and 6 months after cementation. At each follow-up visit, the prosthesis was evaluated clinically for marginal integrity, occlusal stability, connector engagement, abutment tooth mobility, periodontal status, and patient comfort. Also, oral hygiene status was assessed, and oral hygiene instructions were reinforced as needed for the patients.

Fig:1

Fig: 2

Fig: 3

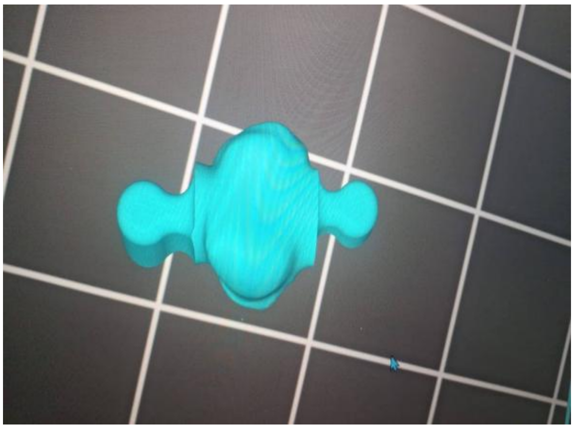

Fig: 4

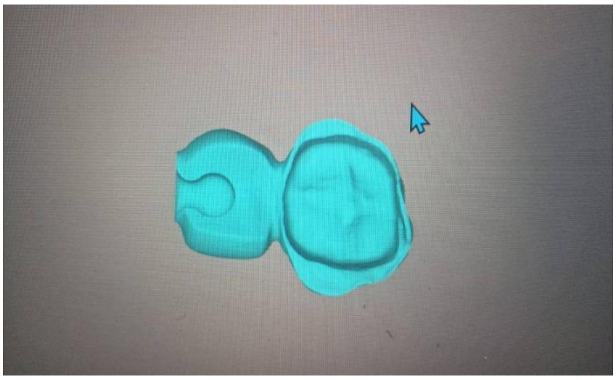

Fig: 5

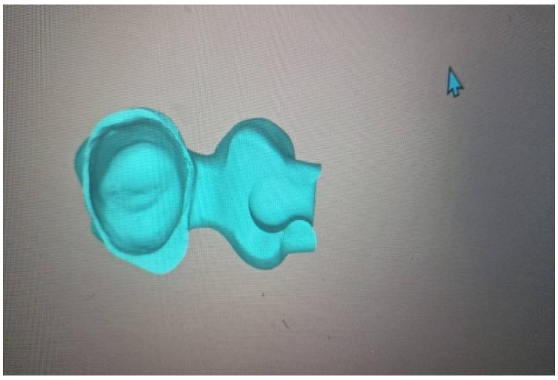

Fig: 6

Fig: 7

Fig: 8

Fig: 9

Fig: 10

Fig: 11

Fig: 12

Discussion

Fixed dental prostheses generally employ rigid connectors due to their ease of fabrication. Conversely, a scenario involving pier abutments presents a challenging circumstance when the center pier abutment acts as a pivot. Since rigidly connected FPDs involving pier abutments have been associated with an increased risk of debonding and other complications [7], a bilateral non-rigid connector on both sides must act as a stress breaker in this situation.[8] However, the use of bilateral non-rigid connectors should be limited and is not advised in situations where the abutment is highly mobile, where the edentulous span on either side of the pier abutment is more than one tooth, or when the FPD with non-rigid connector is opposed by a combination of natural teeth/fixed prosthesis and edentulous ridge/removable prosthesis.[9]

The abutment teeth are protected and prevented from breaking by the stress-relieving or stress-breaking action of bilateral non-rigid connections. However, because of the strain on the abutment tooth's surface, bending in the mesiodistal direction brought on by splinting with a rigid connection causes the fixed prosthesis to fail. The terminal retainers intrude during operation due to force given to them by the presence of a pier abutment. The weaker terminal retainer may fail due to the fulcrum effect exerted by the middle retainer. By using a bilateral non-rigid pier connection that disperses stress in the pier abutment as little as possible, this can be avoided in a five-unit fixed prosthesis. Choosing the right connections is essential to a successful FPD.[9]

Indications for non-rigid connections include fulcrum-like conditions created by the presence of pier abutments, which may lead to intrusion of the pier abutment and failure of the weakest terminal abutment.[10]

The presence of a malaligned abutment may necessitate extensive tooth preparation, where devitalization might occur from parallel preparation. Bilateral external attachments may be employed as connectors to address this scenario. Long-span FPD can be distorted by porcelain's pull and shrinkage on thin framework portions, which can impact how well the prosthesis fits the teeth.[10]

The forces that are impated to the abutment tooth under the soldered retainer would be harmful if the distance between the abutments is more than one tooth. Whereas the two anterior retainers are opposed by natural teeth, the posterior retainer and pontic are opposed by an edentulous ridge or a detachable partial denture.[11]

The use of a bilateral non-rigid connection between the mesial and distal of the second premolar retainer and the mesial of the first molar pontic and distal of the first premolar is discussed in this clinical case report. The second premolar serves as a pier abutment, while the canine and second molar serve as terminal abutments. The connector's size, shape, and type determine how well FPD works. Overloading, leverage, torque, and flexure are some of the factors that may contribute to abnormal stress concentration in FPD.

Long-span FPD failure may result from these aberrant pressures in the cervical dentine region close to the edentulous ridge and surrounding the connector.[12] Savion et al [13] stated that the possible reason for debonding is the development of extrusive reactive forces at the canine retainer as the first molar is loaded due to flexural forces developed within the FPD.

In the present case report, a bilateral non-rigid connector design was selected because the second premolar functioned as a pier abutment between the canine and second molar, creating the potential for differential movement of the anterior and posterior segments. The selected design was intended to minimize the transfer of bending and torqueing forces to the terminal retainers while allowing limited independent movement of the prosthetic segments. [12]

Since placing the non-rigid connection on either of the terminal abutments might result in the pontic acting as a lever arm, Shillingburg et al. recommended placing it on the middle abutment in the five-unit pier abutment repair.[3] The connector's keyway must be inside the usual distal contours of the pier abutment, and the key must be positioned on the medial side of the distal pontic. The long axis of the posterior teeth usually tilts somewhat mesially, and vertically applied occlusal stresses cause further movement in this direction. The key will seat more securely into the connector's keyway if it is placed on the distal side of the pier abutment due to mesial motions. This view is supported by Oruc et al., who conducted a study using a finite element model of a five-unit FPD with a pier abutment, reported that the maximum stress concentration at the pier abutment was reduced when a non-rigid connector was positioned at the distal region of the second premolar [9]. Gill suggested adding a non-rigid connection to one or both sides of the pier abutment. Adams suggested attaching a non-rigid connection to the distal side of the pier and, if desired, adding another one to the distal side of the anterior retainer.[14]

Non-rigid connectors function as stress-relieving elements by permitting limited independent movement between prosthetic segments and redirecting shear forces toward the supporting structures, & reducing stress concentration within the connector.

They may reduce stress concentration at the connector and cervical regions of the FPD and minimize mesiodistal torque on the abutments. [15] By accommodating differences in physiologic tooth movement, non-rigid connectors may also reduce unfavorable stress transfer and the risk of debonding of the terminal retainers. However, their use has certain limitations, including additional tooth reduction of the pier abutment, increased laboratory time and cost, and the possibility of key disengagement from the keyway in the absence of adequate occlusal stability.[10]

Conclusion

The rehabilitation of a pier abutment requires careful consideration for the biomechanical behavior of the prosthesis and the selection and positioning of appropriate connectors. In the present case report, a five-unit porcelain-fused-to-metal FDP incorporating bilateral non-rigid key-and-keyway connectors was used to permit limited independent movement between the anterior and posterior prosthetic segments. The digitally guided workflow facilitated the planned positioning and fabrication of the connector components and their clinical verification. Although the present case demonstrates a feasible clinical approach, longer-term clinical follow-up and comparative studies are required to determine the effect of bilateral non-rigid connectors on stress distribution, prosthesis stability, and clinical longevity.

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