ijlpr 2023; doi 10.22376/ijlpr.2023.13.6.L456-L461

International Journal of Life science and Pharma Research

ISSN 2250-0480

Case Report

Precision Attachment System Incorporated in A Pier Abutment Situation – A Case Report

Aditee Apte[1*], Seema Sathe (Kambala)[2] and Rewa Kawade[3]

[1,3] Post Graduate student, Department of Prosthodontics, Sharad Pawar Dental College, Sawangi (Meghe), Wardha

[2] Professor and Head, Department of Prosthodontics, Sharad Pawar Dental College, Sawangi (Meghe), Wardha

Abstract: In fixed prosthodontics, issues arise when dealing with certain situations, such as pier and tilted abutments, as rigid connectors may not be suitable. Pier abutments are terminal between natural teeth, supporting fixed or removable dental prostheses. FPD connectors are components that connect the retainer and pontic. This study aimed to optimize retention and address long-span edentulism adjacent to the pier abutment. The patient's medical history was not significant, but their dental history revealed extraction of a severely decayed left maxillary second premolar and first and second molars two years ago. A conventional eight-unit FPD with rigid connectors was placed, but it dislodged multiple times within two years. Rigid connectors in this situation would cause the pier abutment to act as a fulcrum due to tooth movement, arch position, and retainer retention. A non-rigid connector was incorporated into the fixed dental prosthesis to address this issue. The use of a non-rigid connector is preferred in constructing an FPD with a pier abutment was the aim of this study. The methodology followed was by placing the keyway on the distal side of the pier abutment aids in seating the key and reducing the risk of dislodgment. Placing the keyway too close to the pier abutment can loosen the key, potentially damaging the canine retainer or causing bone loss around the canine abutment. Non-rigid connectors transfer less stress to abutments and allow for physiologic tooth movement. The design and passive fit of non-rigid connectors are crucial for the success of a long-span FPD. The appropriate connector type is selected during prosthesis construction to prevent separation and failure of the FPD. A non-rigid connector enables movement within the FPD and distributes pressures away from the pier abutment. Therefore, selecting the right architectural design, such as using a key and keyway, holds paramount importance in pier abutment scenarios and plays a crucial role in the overall effectiveness of the Fixed Partial Denture (FPD) treatment. This case study intends to delve into applying a key and keyway as a flexible connector for restoring a patient dealing with a pier abutment condition.

Keywords: Fixed dental prosthesis, Attachments, Precision Attachment, Pier abutment, non-rigid connector

***Corresponding Author**

Aditee Apte , Post Graduate student, Department of Prosthodontics, Sharad Pawar Dental College, Sawangi (Meghe), Wardha.

Received On 12 May, 2023
Revised On 18 September, 2023
Accepted On 16 October, 2023
Published On 1 November, 2023

Funding This research did not receive any specific grant from any funding agencies in the public, commercial or not for profit sectors.

Citation Aditee Apte, Seema Sathe (Kambala) and Rewa Kawade , Precision Attachment System Incorporated in A Pier Abutment Situation – A Case Report.(2023).Int. J. Life Sci. Pharma Res.13(6), L456-L461 http://dx.doi.org/10.22376/ijlpr.2023.13.6.L456-L461

This article is under the CC BY- NC-ND Licence (https://creativecommons.org/licenses/by-nc-nd/4.0)

Copyright @ International Journal of Life Science and Pharma Research, available at www.ijlpr.com

1. INTRODUCTION

The precision attachment denture has long been considered advantageous in dentistry as it combines fixed and removable prosthodontics in such a way as to create the most esthetic partial denture possible.[1] The first line of treatment for replacing missing teeth has traditionally been fixed partial dentures. The abutment teeth, pontic design retainer, connector, and durability of the edentulous span are all important factors in the success of fixed partial dentures (FPD). The most recommended way to construct FPD is using rigid connectors. However, a completely rigid repair is not recommended in some clinical situations, such as Pier abutments.[2] A natural tooth in between terminal abutments is known as an intermediate or pier abutment, and it supports a fixed or portable dental prosthesis.[3] An FPD with the pontic firmly fastened to the retainer gives the prosthesis the necessary strength and stability while reducing restoration-related stresses. A five-unit FPD, however, may not be the best option for the treatment of an edentulous space forms on both sides of a tooth, forming a pier abutment due to physiologic tooth movement, the position of the abutment in the arch, and a variation in the retentive ability of the retainers.[4] Because of the curvature of the arch, the facio-lingual movement of the anterior tooth occurs at a considerable angle to the facio-lingual movement of the molar tooth. These movements can create stress on the abutments in long-span prostheses. A non-rigid connector, a stress-breaking mechanical union of retainer and pontic, is usually recommended in such a situation.[5] Unusual stress concentration in an FPD is caused by biomechanical factors such as overload, leverage, torque, and flexing. The prosthetic connectors and the cervical dentin region are where stress is concentrated next to the edentulous ridge. Additionally, this element is crucial to the long-span FPD's failure. The part of the FPDs called connectors joins the retainers and pontics together. Rigid and nonrigid connectors are the two types that exist.[4] When an occlusal load is applied to the retainer on the abutment tooth at 1 end of a fixed partial denture with a pier abutment, the pier abutment may act as a fulcrum. Thus, tensile forces may be generated between the retainer and abutment at the other end of the restoration. Anterior or posterior abutments may experience extrusive forces during fulcrum action. The resultant tensile force at the retainer to abutment interface may result in potential loss of retention for these restorations.[6] Different processes, like casting, soldering, and welding, create rigid connectors. Wax patterns must be used to shape the cast connections appropriately. The nonrigid connector is the one that allows some movement among the otherwise independent FPD elements. The prefabricated plastic designs, a bespoke milling machine, or the integration of prefabricated inserts might all be used to create the non-rigid connector.[4] A non-rigid connector acts as a breaking mechanical union of retainer and pontic, which is used in the form of a key (tenon), which will be attached to the pontic and a key-way (mortise), which will be placed within the retainer.[7] The choice of architecture, specifically the key and keyway, is crucial in pier abutment cases and greatly affects the success of the fixed dental prosthesis (FPD). This case report aims to use a non-rigid connector, the key, and the keyway to rehabilitate a patient with a pier abutment situation. Rigid connectors would create a fulcrum effect due to tooth movement, arch position, and retainer retention. To overcome this issue, a non-rigid connector was incorporated into the FPD. A non-rigid connector is preferred for pier abutment cases as it allows for physiologic tooth movement and reduces abutment stress. Proper placement of the keyway on the distal side of the pier abutment helps secure the key and minimize the risk of dislodgment. Placing the keyway too close to the pier abutment can lead to key loosening, potential damage to the canine retainer, or bone loss around the canine abutment. It is essential to design the non-rigid connector with a passive fit to ensure the success of a long-span FPD. By using a non-rigid connector, movement within the FPD is allowed, and pressures are distributed away from the pier abutment, minimizing the risk of separation and failure

2. CASE REPORT

A 45-year-old male patient was reported to the Department of Prosthodontics of Sharad Pawar Dental College and Hospital, Wardha, with a chief complaint of dislodged prosthesis, difficulty in mastication, and aesthetic problems.

2.1. Medical History and Family History

Past medical history was significant, and past dental history revealed that the patient had undergone extraction of the badly carious left maxillary second premolar and first and second molar two years back, followed by conventional eight-unit FPD with rigid connectors; this FPD dislodged several times in two years. Family history is not significant.

2.2. Observation

On Intraoral examination as seen in Figure 1, it revealed missing left maxillary canine, second premolar, and maxillary first and second molar with left maxillary lateral incisor and left maxillary third molar acting as terminal abutments and first premolar acting as a pier abutment. Tooth-colored filling seen with maxillary left first premolar and maxillary third molar.

Fig 1: Intraoral examination showing missing 23, 25, 26, and 27 in maxillary arch.

2.3. Special Tests and Investigations and Diagnosis

On radiographic evaluation, the abutment teeth had adequate bone support to be used as abutment. After discussing all the treatment options and their pros and cons, it was decided to rehabilitate the case with a unit FPD using non-rigid connectors on the distal aspect of a pier abutment. Its risks and benefits were explained to the patient, and written, informed consent was obtained.

2.4. Prognosis, Treatment plan, and step-by-step Clinical procedure

The prognosis of the case was good, and further treatment procedure was carried out. The following clinical step-by-step procedure was carried out for his oral rehabilitation,

1. To enhance aesthetics, tooth preparation was modified for porcelain fused to metal prosthesis on the left maxillary lateral incisor and maxillary first premolar with equigingival margins and shoulder finish line.
2. Figure 2 illustrates tooth preparation modification for full metal coverage on the left maxillary third molar with supragingival margin and chamfer finish line. The gingival retraction was carried out with a gingival retraction cord, and final impressions were made using elastomeric impression material with a step putty wash technique.[2]

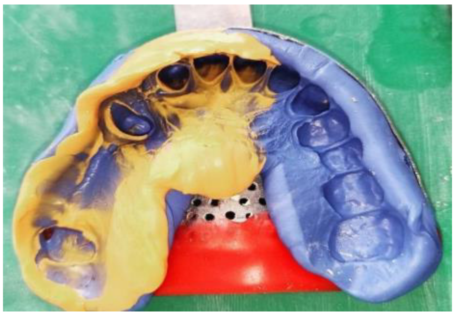

Fig 2: Final Impression made using elastomeric impression material.

3. An interocclusal record was made using bite registration material. Provisional restorations were fabricated with a tooth color auto-polymerizing acrylic resin and cemented with non-eugenol temporary cement. The impression was poured into a type IV dental stone. The master cast was retrieved, and die-cutting was done. Master casts were mounted on an articulator using interocclusal records.
4. The wax pattern was fabricated, and then the recess for the female was cut accordingly to fit the prefabricated plastic dovetail on the distal aspect of the pier abutment. Surveying was done to determine the position and parallelism of the plastic dovetail; the plastic dovetail female was placed within the correct contour of the pier abutment. The casting of the male pattern was carried out.
5. Figure 3 depicts the fabrication of a complete PFM bridge with matrix and patrix with the retentive sleeve incorporated.

Fig 3: PFM bridge with matrix and patrix with the retentive sleeve incorporated.

6. During cementation, the anterior three-unit segment with a keyway was cemented first, followed by the cementation of the posterior two-unit segment with a key using glass ionomer cement, as seen in Figure 4.

Fig 4: Cementation of the FPD.

The patient was instructed to maintain proper oral hygiene. The use of dental floss and interdental brush was recommended. The patient was evaluated after one week to assess the oral hygiene status.

3. DISCUSSION

Conventional rigid connectors are the preferred way of fabrication of FDP because the rigidity of the connection between the pontic and the retainers provides desirable strength and stability to the prosthesis while minimizing the stresses associated with the restoration. However, this solution is only applicable in some scenarios.[8] According to Schillinburg et al., every restoration must withstand the constant functional and parafunctional forces to which it is subjected.[9] This is of particular significance when designing and fabricating an FPD since the forces normally absorbed by the missing tooth were transmitted to the abutment teeth through the pontic connector and retainers. If exceeded beyond the physiologic limits of hard tissues, these forces can cause initial bone loss and failure of the prosthesis.[10] Pier abutment, also named intermediate abutment, is defined by the Glossary of Prosthodontic Terms as a natural tooth between terminal abutments that support a fixed or removable dental prosthesis. This pier abutment acts as a fulcrum because of its strategic position when it is subjected to occlusal forces acting on the ends of the prostheses that will tend to lift the other end like a class I lever, causing stress on the terminal abutments and ultimately failure of the fixed dental prosthesis and trauma to the periodontium.[11] Connectors are part of a fixed partial denture (FPD) that unites the retainers and pontics. Connectors may be rigid (solder joints or cast connectors) or non-rigid (precision attachment or stress breaker). Rigid connectors between retainers and pontics are the preferred way of fabricating most FPDs.
Indications for non-rigid connectors are as follows:
• The presence of pier abutments, which encourage a scenario akin to a fulcrum that may lead to the failure of the terminal abutments and the intrusion of pier abutments.
• The malaligned abutment's presence, where concurrent preparation can cause devitalization. Intracoronal attachments can be used as connectors to resolve this problem.
• Long-span FPDs that may distort due to porcelain pulling and shrinking on delicate portions of the framework will influence how well the prosthesis fits over the teeth.
• As the mandible rotates mediolaterally during its opening and closing strokes, a non-rigid connection is seen in the mandibular arch, FPD, which consists of both posterior and anterior segments.
• Differences in the abutments' ability to retain.[12]
Selecting the right type of connector during treatment planning is an essential step for the success and failure of the prosthesis.[6] An FPD requiring the restoration of two missing teeth and where an intermediate pier abutment is present with a single casting (rigid connectors) is not an ideal treatment. Markley (1951) suggested that a non-rigid connector should be placed at one of the terminal retainers.[13] Gill (1952) recommended placing a non-rigid connector at one or both sides of the pier abutment. Schillinburg et al. (1973) suggested that the patrix of the nonrigid connector should be placed distal to the pier retainer & matrix should be in the distal pontic.[9,14] According to a study conducted by Selcuk Oruc & Arzu Atay, the stress distribution & values of an FPD and pier abutment are affected by the presence & location of a non-rigid connector. The nonrigid connector is a broken-stress mechanical union of retainer and pontic instead of the usual rigid connector. Botelho and Dyson reported that rigid FPDs with pier abutments are linked with higher debonding rates than short-span prostheses. Therefore, accurate planning of the design philosophy was critical for the reflexive fit of non-rigid connectors, which prevented the leverage effect to a large extent and imparted it to the long-term success of the long-span FPD with pier abutments.[5] Posterior teeth' long axis tends to tilt mesially. Occlusal forces applied vertically produce further movement in this direction. It would eliminate the fulcrum effect, and the patrix/male of the attachment will be seated firmly in place when pressure is applied distally to the pier.[7]
Non-rigid connectors are contraindicated in certain situations like:
1. Mobility of abutments.
2. When the abutments between the spans are longer than one tooth.
3. If the distal retainer and pontic are opposed by a removable partial denture/edentulous ridge and two anterior retainers are opposed by natural dentition, the distal terminal abutment to supra erupt.
Designs of the nonrigid connectors are key & keyway (Tenon-Mortise), cross–pin and wing, loop and split connectors. The most commonly used design is mortise (female component) placed within the contours of the retainers and a Tenon (male 14 component) attached to the pontic. Positioning the dovetail or cylindrically shaped mortise is important as it must be parallel to the path of withdrawal.[7]
The advantages of Tennon mortise design are as follows: -
1. Relieve stress on abutments.
2. Splinting of periodontically weakened teeth.
3. Allows for easy repair.
4. In case of fracture, only the defective segment has to be removed and repaired.
Disadvantages: -
1. Time consuming.
2. Cost factor.
3. Require extensive tooth preparation.
Biomechanical features such as overload, leverage, torque, and flexing can lead to abnormal stress concentration in FPD. When the stress distribution of different design types was compared, high-stress values were shown at the connectors and cervical regions of the abutment teeth near the region of the pier abutment. Other stress concentration areas were apical aspects and root surfaces. These factors play a vital role in the potential for failure in long-span FPD.[7] The presence of pier abutments foster a fulcrum-like scenario that may lead to the failure of the weakest terminal abutments and the intrusion of a pier abutment. Because shear pressures are centered on the supporting bone rather than the connection in a stress breaker, a pier abutment on each end of the nonrigid connector is advised. A stress breaker reduces the amount of mesiodistal torquing on abutments and allows them to move freely.[15] According to the literature, there are four different kinds of nonrigid connectors, including Tenon-Mortise type connectors, Cross-pin and Wing type connectors, Split type connectors, and Loop type connectors. The most popular form is the Tenon-Mortise type, where precise Mortise positioning is technique-sensitive since it must establish parallelism for the precise course of distal retainer removal. The success or failure of the restoration depends on choosing the proper type of connector.[16] The stiff FPD design prevents the abutment from responding independently under vertical loading situations. The abutments can respond to vertical loads independently thanks to the nonrigid FPD design.[17]

Researchers who used quasi-three-dimensional photo elastic stress evaluation concluded that the FPDs showed signs of stress and occlusal displacement under continuous loading.[18] In a study conducted by Savion et al., in 2006 using a mathematical model, the author concluded that debonding might occur in the anterior abutment but not due to the FPD teetering adjacent to the pier abutment.[19] Conventional rigid connectors are commonly used in fabricating fixed dental prostheses (FDPs) as they provide strength and stability while minimizing stress. However, this approach may only be suitable for some cases. It is crucial for any restoration, especially FDPs, to withstand constant functional and parafunctional forces. In the case of FDPs, the forces normally absorbed by the missing tooth are transmitted to the abutment teeth through the pontic connectors and retainers. If these forces exceed the physiological limits of the surrounding tissues, it can lead to bone loss and prosthesis failure. A pier abutment, positioned between terminal abutments, acts as a fulcrum and experiences stress due to occlusal forces, which can lead to failure of the dental prosthesis and trauma to the periodontium.

4. CONCLUSION

In cases requiring pier abutments, especially five-unit bridges, the stiff connectors are a less suitable plan of treatment due to issues including physiologic tooth movement, arch location of the abutments, and retentive ability of retainers. The rigid connection to two or more teeth creates enormous leverage forces, and broken stress measures act as "safety valves" to counteract these forces. The size, shape, and type of connectors play an important role in the future success of a FPD. The selection of a proper connector is an important step in the treatment planning of pier abutment. Non-rigid connectors transfer less stress to abutments, also allowing physiologic tooth movement. Thus, the design and passive fit of non-rigid connectors is significant to the success of a long-span fixed partial denture.

5. AUTHORS CONTRIBUTION STATEMENT

Dr. Aditee Apte conceptualized and made the design and drafted the data for the study along with Dr. Rewa Kawade. Dr. Seema Sathe (Kambala) discussed the methodology, analyzed the data, and provided valuable inputs for designing the manuscript. All authors read and approved the final version of the manuscript.

6. ETHICAL STATEMENTS

Ethical Statement: Permission was obtained from our institution, Sharad Pawar Dental College, Datta Meghe Institute of Higher Education and Research, Wardha to conduct and publish the case study. The patient was explained the study's purpose, and informed written consent was received for conducting the procedure and publishing the study. Assurance about confidentiality was given to the patient. The case was conducted according to the guidelines of the Declaration of Helsinki for biomedical research involving human subjects.

7. ACKNOWLEDGEMENTS

Dr. Aditee Apte conceptualized and gathered the data about this work and drafted the manuscript. Dr. Seema Sathe (Kambala) analyzed these data, and necessary input was given to the design of the manuscript. Dr. Rewa Kawade and Dr. Vedant Pathak contributed to the writing of the manuscript. All authors discussed the methodology and conclusion and contributed to the final manuscript.

8. CONFLICT OF INTEREST

Conflict of interest declared none.

9. REFERENCES

1. Jain R, Aggarwal S. Precision attachments- An overview. IP Ann Prosthodont Restor Dent. 2017;3:6-9.
2. Rami D, Sethuraman R, Parmar V, et al. Non-rigid connectors in fixed prosthodontics: a stress breaker for pier abutment. Int J Sci Res. epub ahead of print March 2020;9. doi: 10.36106/ijsr.
3. Nisal S, Banik M, Gade J, et al. Management of pier abutment using Non-rigid connector: A case report. J Int Oral Health;2.
4. Sivakumar S. Management of partial edentulism using nonrigid connectors as a treatment modality: A case report. Cureus. 2020;12(4):e7790. doi: 10.7759/cureus.7790, PMID 32461861.
5. Venkataraman K, Krishna R. The lone standing abutment: A case report. Int J Appl Dent Sci. 2016;2:20-3.
7. Banerjee S, Khongshei A, Gupta T, Banerjee A. Non-rigid connector: the wand to allay the stresses on abutment. Contemp Clin Dent. 2011;2(4):351-4. doi: 10.4103/0976-237X.91802, PMID 22346166.
8. Begum F, Uthappa MA, Salagundi BS, Rupesh PL, Kataraki B, Abraham S. Maxillary fixed-fixed FPD with precision attachment: A clinical report. JMDR. 2020;5(1):49-55. doi: 10.38138/JMDR/v5i1.9.
9. Mishra A, Palaskar J, Madhav V, et al. Pier abutment: break the stress. 2016;2:126-8.
10. Shillingburg H, Hobo S, Whitsett L, et al. Fundamentals of fixed prosthodontics. Chicago: Quintessence Publishing; 1997.
11. Oruc S, Eraslan O, Tukay HA, Atay A. Stress analysis of effects of nonrigid connectors on fixed partial dentures with pier abutments. J Prosthet Dent. 2008;99(3):185-92. doi: 10.1016/S0022-3913(08)60042-6, PMID 18319089.
12. Rosenstiel SF, MF, et al. Contemporary fixed prosthodontics. 3rd ed. St Louis: Mosby Inc; 2001.
13. Ravikumar A. Non-rigid connector for managing pier abutment in FPD: A case report. *JCDR*. epub ahead of print 2014. doi: 10.7860/JCDR/2014/9710.4572.
14. Markley MR. Broken-stress principle and design in fixed bridge prosthesis. J Prosthet Dent. 1951;1(4):416-23. doi: 10.1016/0022-3913(51)90027-3, PMID 14851319.
15. Botelho MG, Dyson JE. Long-span, fixed-movable, resin-bonded fixed partial dentures: a retrospective, preliminary clinical investigation. Int J Prosthodont. 2005;18(5):371-6. PMID 16220800.
16. Badwaik P, Pakhan A. Non-rigid connectors in fixed prosthodontics: current concepts with a case report. J

Indian Prosthodont Soc. 2005;5(2):99. doi: 10.4103/0972-4052.16879.
17. Malone WFP, Koth DL, Cavazos E, et al. Tylman's theory and practice of fixed prosthodontics. 8th ed, reprint. St Louis: Ishiyako EuroAmerica; 2001.
18. Sutherland JK, Holland GA, Sluder TB, White JT. A photoelastic analysis of the stress distribution in bone supporting fixed partial dentures of rigid and nonrigid design. J Prosthet Dent. 1980;44(6):616-23. doi: 10.1016/0022-3913(80)90457-6, PMID 7003121.
19. Standlee JP, Caputo AA. Load transfer by fixed partial dentures with three abutments. Quintessence Int. 1988;19(6):403-10. PMID 3077679.
20. Savion I, Saucier CL, Rues S, Sadan A, Blatz M. The pier abutment: a review of the literature and a suggested mathematical model. Quintessence Int. 2006;37(5):345-52. PMID 16683681.