Dental Journal
Majalah Kedokteran Gigi

Dental Journal
(Majalah Kedokteran Gigi)
2025 March; 58(1): 100–106

Case report

Hemisection with socket preservation using alloplastic bone graft and platelet-rich fibrin

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ABSTRACT

Background: *The developments in endodontics have created opportunities for patients to maintain functional teeth for longer. Surgical endodontic treatment, such as hemisection, has become a more conservative treatment than complex treatments, such as removable or fixed partial dentures or implants.* ***Purpose:*** *The aim of this treatment is to preserve the remaining tooth structure through a hemisection procedure and socket preservation using an alloplastic bone graft and platelet-rich fibrin (PRF).* ***Case:*** *A female patient presented with mastication pain and a large carious tooth in the right mandibular first molar and wanted to save the tooth. Examination showed deep caries and perforation in the bifurcation area of the tooth with loss of the distal crown. However, the mesial root could be preserved, thus hemisection was proposed.* ***Case management:*** *A root canal treatment was performed on the mesial root, followed by separation of the mesial and distal roots, and, finally, distal root extraction. A mixture of PRF and bone graft was used for socket preservation. The tooth was restored with a splinted zirconia crown.* ***Conclusion:*** *Hemisection with socket preservation using alloplastic bone graft and PRF represents a more conservative treatment option for molar teeth with extensive caries. This approach exhibits a good long-term prognosis and enhances the bone healing process.*

Keywords: *bone graft; hemisection; human and health; platelet-rich fibrin*
Article history: *Received 9 January 2024; Revised 16 March 2024; Accepted 18 April 2024; Published 1 March 2025*

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INTRODUCTION

Making the decision to keep an extensively decayed tooth or perform an extraction is not always easy for dentists. The use of removable or fixed dentures can be an option to replace the teeth that have been extracted, but the patient's comfort will not be the same as if the original teeth can still be maintained.[1,2] In recent decades, dental implants have gained popularity for replacing damaged teeth, but due to the increasing evidence of complications and the difficulty in managing these complications, dentists are required to adopt a more conservative approach by retaining the tooth and delaying extraction.[3]

Advances in modern dentistry have led to the development of safer treatment techniques. Dentists may choose specific treatments for endodontic and periodontal problems in patients with extensive caries and furcation damage, allowing patients to choose to maintain their teeth functionally for as long as possible.[4] Some experts believe that preserving part or one of the roots of the tooth is better than complete extraction.[5] Hemisection is a surgical procedure for a multirooted tooth that involves separating the roots and removing the part of the root that is not functioning properly to create a healthy periodontal environment and restore the mastication function through prosthetics.[4,5]

Indications for hemisection treatment include the presence of severe bone destruction of the roots or furcation that is incompatible with other surgical treatment options, unfavorable root approximation to other periodontal

DOI: 10.20473/j.djmkg.v58.i1.p100–106

treatment options, unrepairable roots or fractured instruments, perforations, caries, canal calcifications, resorption, and vertical root fractures. Contraindications for hemisection include inadequate bone support for the remaining root, the inability to treat the remaining root with root canal therapy, a fused root that cannot be separated, unfavorable postoperative restorative margins, and poor patient hygiene.[6] The success or prognosis of endodontic surgery, including hemisection, depends on the factors of diagnosis, case selection, indication accuracy, contraindications, treatment procedures, and routine evaluations.[5,6]

The aim of this article is to present the hemisection procedure, which is one of the endodontic surgical procedures indicated for a problematic lower right first molar with bifurcation perforation, where one root canal cannot be treated conventionally. In this case, platelet-rich fibrin (PRF) and bone graft were used for socket preservation after the hemisection procedure. PRF and bone graft are the most frequently employed materials in regenerative surgical procedures, followed by restoring the tooth through maintaining the mesial root with a splinted zirconia crown.

CASE

A 31-year-old female patient came to the Conservative Dentistry Department of the Dental Hospital in Airlangga University, Surabaya, Indonesia, on April 19, 2022, with a complaint of pain when chewing and large caries in the first right mandibular molar. The patient wanted the tooth to be treated. Upon clinical examination, there were deep caries and perforation on the bifurcation of tooth 46 (Figure 1a), positive percussion, a positive bite test, and normal surrounding gingiva. A Miller broach (Dentsply, USA) was used for the vitality test, which showed no pain, and it was concluded that the tooth was not vital. A radiographic examination revealed extensive carious radiolucency over the bifurcation area with loss of the distal crown and diffuse radiolucency in the periapical and mesial roots of tooth 46 (Figure 1b). The patient did not have parafunctional habits, such as bruxism and clenching, and she reported no history of systemic disease or drug allergies. The diagnosis of tooth 46 was pulp necrosis with symptomatic apical periodontitis.

The patient was provided with information about the condition of the tooth and received education about dental and oral health. The treatment plan included the option of endodontic surgery with hemisection on tooth 46 due to damage from caries and inadequate residual tissue. The patient chose to proceed with this treatment plan along with a restoration involving a splinted zirconia crown for tooth 46 and a mesial rest on tooth 47.

CASE MANAGEMENT

Prior to the procedure, the patient signed a consent form. Isolation was done using a rubber dam, and access opening

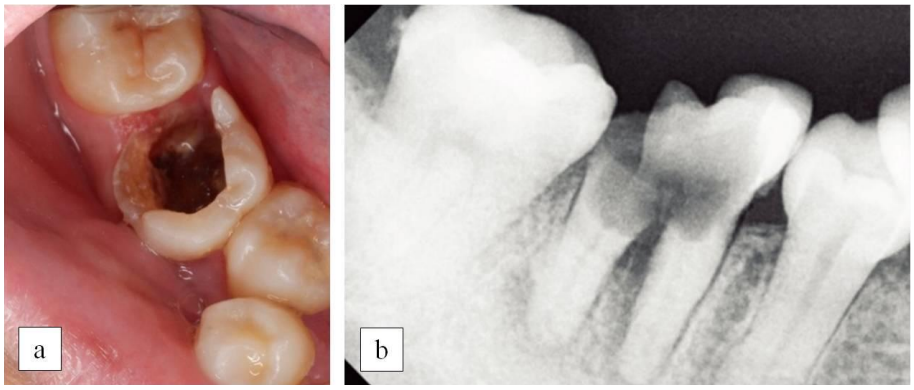

Figure 1. (a) Clinical view of tooth 46 before treatment; (b) Pre-operative radiographic image of tooth 46.

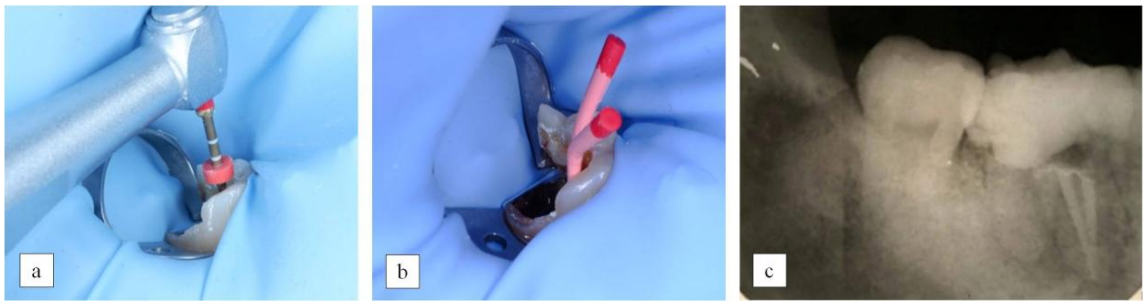

Figure 2. (a) Canal shaping using ProTaper Gold; (b) Obturation performed with single-cone technique using gutta-percha #F2 and a resin-based sealer; (c) Radiographic photo confirming obturation.

DOI: 10.20473/j.djmkg.v58.i1.p100–106

and root canal negotiation were performed with K-file #10 (Dentsply, USA). Working length was measured with an apex locator (Morita, Japan). The estimated working length for the mesiobuccal root was 17 mm and 18 mm for the mesiolingual root. Apical patency was achieved using K-file #25 (Dentsply, USA). Preparation continued with ProTaper Gold rotary files until F2 (Dentsply, USA) using the crown-down technique (Figure 2a). The root canal was cleaned with 2.5% sodium hypochlorite (NaOCl) and activated irrigation material using an EndoActivator (Dentsply, USA). It was then flushed with sterile aquadest, irrigated with 17% Ethylenediaminetetraacetic acid (EDTA), and flushed with sterile aquadest. The root canal was dried with a paper point. Calcium hydroxide ($Ca(OH)_2$) was used as an intracanal medicament, and then a temporary filling (Cavit 3M, USA) was applied in the cavity.

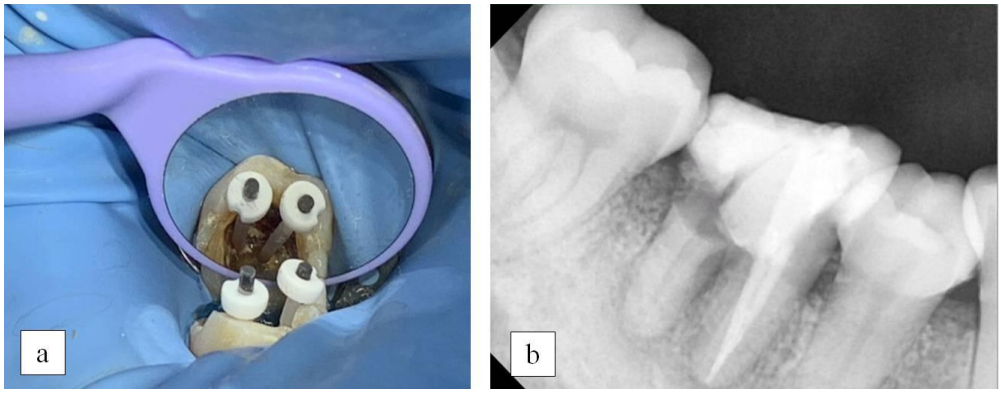

Figure 3. (a) Fiber post inserted into the canal; (b) Radiographic photo confirming fiber post insertion.

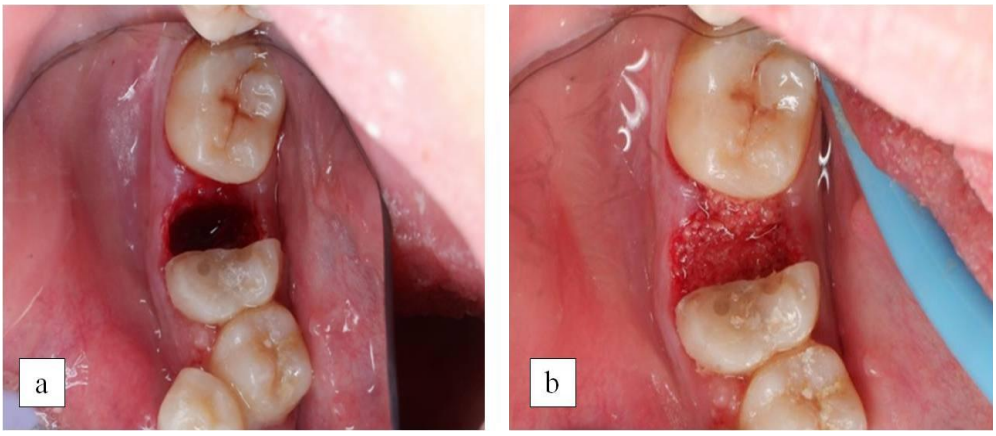

Figure 4. (a) Clinical view after extraction and separation of the mesial and distal roots using a fissure bur; (b) Application of the mixture of bone graft and PRF in the socket.

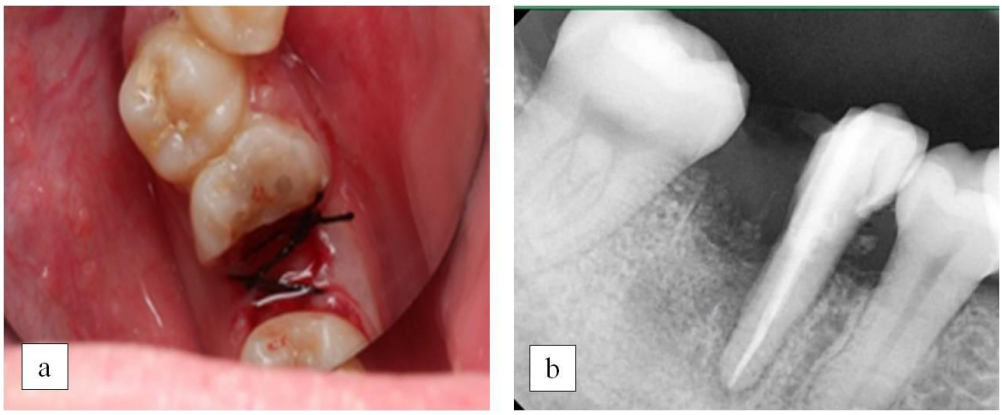

Figure 5. (a) Gingiva sutured with a figure-of-8 technique; (b) Radiograph after tooth separation and distal root extraction on the same day.

DOI: 10.20473/j.djmkg.v58.i1.p100–106

Two weeks later there were no complaints, and the clinical examination showed negative percussion and a negative bite test. A temporary filling was opened under the rubber dam isolation, and the $Ca(OH)_2$ was washed with 2.5% NaOCl while activated using an EndoActivator (Dentsply, USA). A trial of gutta-percha was performed using gutta-percha ProTaper #F2 to confirm there was tug-back, and a radiographic image was taken for confirmation. Final irrigation was carried out with 2.5% NaOCl plus activation of irrigation material using an EndoActivator (Dentsply, USA), then flushed with sterile aquadest, irrigated with 17% EDTA, and flushed again with sterile aquadest. The root canal was dried with a paper point. Obturation was performed with a single-cone technique using gutta-percha #F2 and a resin-based sealer (Dentsply, USA), then a temporary filling (3M, USA) was applied in the cavity (Figure 2b), and radiographic confirmation was taken (Figure 2c).

The canal was measured using post size templates (LuxaPost DMG, Germany). The gutta-percha was reduced with a Peeso reamer (Dentsply, USA) and a post drill (DMG, Germany), and then the canal was irrigated using sterile aquadest. A fiber post (DMG, Germany) was used to check the suitability of the preparation results (Figure 3a). Universal bonding (3M, USA) was applied in the canal and cured for 20 seconds. The fiber post (LuxaPost DMG, Germany) was cemented using dual-cure adhesive resin cement (LuxaCore DMG, Germany), and radiographic confirmation was taken (Figure 3b).

One week later, pre-operation blood tests were carried out to check vital signs and ensure a normal blood sugar level. The blood sample was collected from the antecubital vein, transferred to a test tube, and centrifugated at 3000 rpm for 10 minutes. During centrifugation, three layers formed in the tube—platelet-poor plasma on the surface, a PRF clot in the middle, and red blood cells at the bottom. Sterile tweezers were used to scoop the fibrin clot out of the tube, and sterile scissors were used to cut and insert the PRF into a dappen glass.[7,8]

Isolation of the operating area was achieved using a sterile cloth cover. Extraoral and intraoral asepsis was performed using betadine solution, and anesthesia was carried out with a mandibular block and local infiltration of buccal tooth 46 with 2 cc of pehacaine. The mesial and distal roots were separated with a fissure bur, the distal root was extracted, and a curettage procedure was carried out in the socket (Figure 4a). The full PRF clot and single-pack bone graft (Gama-CHA, Indonesia) were mixed in a dappen glass and applied to the extraction socket (Figure 4b), then the gingiva was sutured with a figure-of-8 technique

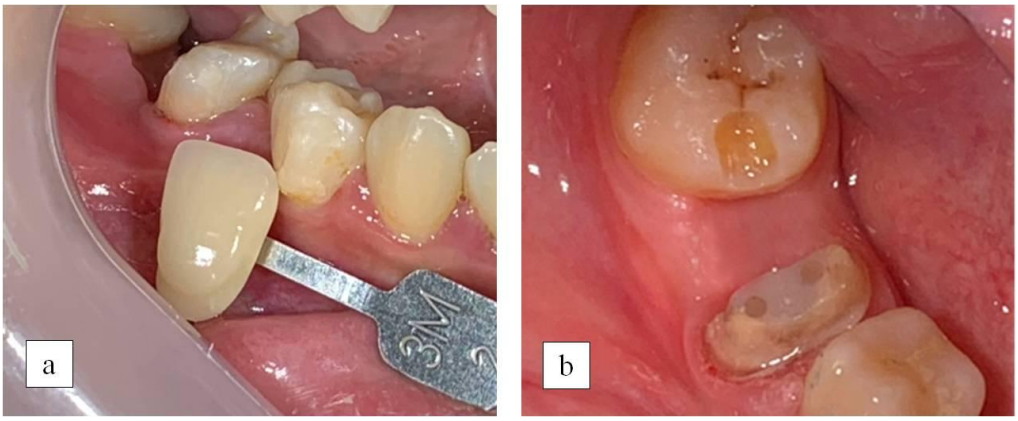

Figure 6. (a) Shade guide taken using Vita 3D Master 3M2; (b) Crown and rest mesial preparation.

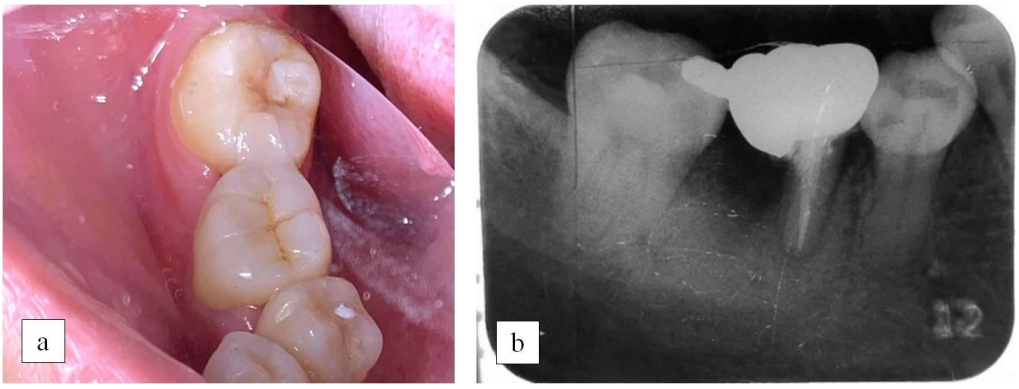

Figure 7. (a) Splinted zirconia crown cemented; (b) Radiographic photo taken after three months of endodontic surgery and cementation of the splinted zirconia crown.

DOI: 10.20473/j.djmkg.v58.i1.p100–106

(Figure 5a), and a post-surgery radiographic image was taken (Figure 5b). Antibiotics and anti-inflammatory drugs were prescribed. Post-operative instructions were given to keep the wound clean: brush teeth carefully, avoid excessive rinsing, don't consume drinks or food that are too hot, and eat on the opposite side to where the procedure was carried out.

One week after the surgery, there were no complaints of pain, there was no swelling, and the sutures were in good condition. The teeth were irrigated using a saline solution, and the sutures were removed. At the visit three months later, there were no complaints of pain, and the socket post-extraction had closed well. The Vita 3D Master 3M2 Shade Guide was used to determine tooth color (Figure 6a). Crown preparation was carried out with a 1–1.5 mm chamfer margin reduction was carried out on the buccal, lingual, and proximal teeth, and 1.5 mm on the occlusion tooth. The mesial rest of tooth 47 was prepared using a round diamond bur (Figure 6b). An impression of the teeth was made for a working cast model with a double impression using polyvinyl siloxane and the antagonistic tooth with irreversible hydrocolloid, and a bite registration was made using polyvinylsiloxane. A temporary crown was placed on teeth 46 and 47, and minimal contact of the occlusal site was ensured to reduce occlusal and lateral loads. The dental impression was sent to the dental laboratory for the fabrication of a splinted zirconia crown.

When the final crown was ready, the provisional crown was removed, and a splinted zirconia crown was evaluated for marginal fit, proximal fit, and occlusion. Prior to cementation, the zirconia crown was sandblasted on the inner surface with aluminum oxide in the laboratory. Primer zirconium 10 methacryloyloxydecyl dihydrogen phosphate was applied to the inner surface of the zirconia crown, and then the crown was cemented using a dual-cure, self-etch, self-adhesive resin composite (3M, USA) (Figure 7a). Before curing, glycerin was applied to the margins of the restoration to prevent the formation of an oxygen-inhibiting layer, which can interfere with polymerization by reducing surface hardness and roughness. Then, curing was carried out for 1–2 seconds, the remaining cement was cleaned, followed by a final light curing for 20 seconds. The rubber dam was removed, and the crown was evaluated for occlusion, articulation, margin adaptation, and proximal contact. A radiographic photo was taken after the cementation of the splinted zirconia crown and used for evaluation three months after the endodontic surgery (Figure 7b). The radiographic photo shows that the extraction socket is filled with solid bone.

DISCUSSION

Modern dentistry has shifted toward more conservative treatment approaches. Endodontic surgical treatments, such as hemisection, help to prevent tooth loss and avoid more invasive and complex procedures, such as removable or fixed dentures or implants.[9] According to the American Association of Endodontists, hemisection is the surgical separation of a tooth with multiple roots through the furcation and removal of one of the roots and the associated portion of the crown to retain the tooth.[10]

In this case, socket preservation using bone graft and PRF becomes necessary to promote bone healing. Socket preservation is employed as a technique to reduce alterations in the dimensions of the alveolar bone by promoting bone formation, thereby establishing equilibrium between bone formation and resorption. This process involves attaching a bone graft to the socket or defective area in the bone.[11,12] The bone graft may be transplanted into the deformed bone either alone or in combination with other materials. The characteristics of a bone graft as a replacement material must be physiologically inert, non-carcinogenic, easily degradable, and have a stable structure. In addition, a bone graft must also possess osseointegration, osteogenic, osteoconduction, and osteoinduction properties. The ability of the graft material to chemically bond to the bone surface without an intervening layer of fibrous tissue is called osseointegration. Osteogenesis refers to the formation of new bone by osteoblasts or progenitor cells, and osteoconduction refers to the ability of bone graft materials to generate bioactive scaffolds on which host cells can grow. This structure allows the migration of host blood vessels, osteoblasts, and host progenitor cells into the osteomatrix.[13,14] Osteoinduction is the recruitment of host stem cells to the implantation site and the induction of stem cell differentiation into osteoblasts. Several growth factors influence this process, including fibroblast growth factors, platelet-derived growth factors, and transforming growth factors.[15]

Alloplastic materials do not trigger an immune response or transmit diseases and have been created as alternatives to autografts, allografts, and xenografts. These synthetic bone grafts come in a wide variety of shapes, sizes, and configurations. Advances in technology have enhanced their surface texture, mineral production, and biocompatibility, allowing them to closely resemble natural bone.[16]

The application of other biomaterials, such as PRF, can enhance the healing process. Furthermore, the combination of PRF also affects the soft tissue healing process, as PRF serves as a biodegradable scaffold composed of leukocytes, platelets, and fibrin, thereby boosting microvascularization and epithelial cell migration.[17] Platelets have many functions other than hemostasis. Platelets contain important growth factors, which, when secreted, are involved in increasing collagen production, recruiting other cells to the site of injury, initiating blood vessel growth, and inducing cell differentiation. These are all important steps in early wound healing. PRF allows one to obtain a fibrin membrane enriched with platelets and growth factors after initiating anticoagulant-free blood sampling. Recently, studies have shown that PRF has a highly significant sustained release of many key growth factors for a minimum of one week and up to 28 days and that PRF can release growth factors

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with its own biological scaffold for the wound-healing process.[18–20] Although hemostasis is the primary role of fibrin in wound healing, fibrin also provides a matrix for the migration of fibroblasts and endothelial cells involved in angiogenesis and the remodeling of new tissue. PRF also inhibits osteoclastogenesis by stimulating the secretion of osteoprotegerin, thus helping to maintain alveolar ridge height following extraction.[19] The combination approach in which PRF is used together with bone graft maximizes regenerative outcomes. Filling the defective area with PRF and bone graft enhances new bone formation by providing growth factor-enriched surroundings, thereby exerting a positive effect on tissue healing.[21] Existing literature shows that the use of PRF and bone graft demonstrates better clinical outcomes in bone formation compared to using bone graft alone or neither.[22]

Successful hemisection is dependent on the case selection analysis, the quality of the residual root canal treatment, the final restoration quality, the alveolar bone support, and the patient's oral hygiene.[9] Continuation of completed endodontic treatment with good prosthesis is essential for successful treatment. Postoperative clinical and radiographic assessment should show increased healing of the bony lesions at the three-month follow-up, and the tooth should be sufficiently healed for crown placement.[19]

The amount of bone support around the remaining root is another important factor in the success of a fixed prosthesis. The remaining roots require restoration with a post and core as abutments for fixed partial dentures.[23] Another factor to consider for a successful restoration is that the periodontal surface area of the abutment must be greater than or equal to the surface area of the missing tooth.[24] A splinted crown has several advantages, including being more conservative and less damaging to the vital hard tissues. Restoration of fixed dentures with rests as retainers is an alternative to a full crown. Using the rest as a splint suggests a more conservative preparation for restoring periodontal health because a hemisection allows for physiological mobility of the remaining root while maintaining a balanced occlusion. Compared with rest preparation, full crown preparation causes more damage to vital tissues.[6,24,25]

Ultra-translucent zirconia (5Y-PSZ) was chosen because it has good strength but still provides aesthetics. The flexural strength of 5Y-PSZ is about 700 MPa, and in this case, the antagonist teeth were in good condition with no signs of wear. This material can be chosen if the patient has healthy periodontal tissue and does not have a parafunctional habit.[26] The disadvantage of a splinted crown is the easy occurrence of food impaction, but this can be minimized by shaping the anatomy of the remaining tissue. It must be prepared properly and carefully by forming smooth margins, as well as providing access for good hygiene by the patient; the pontic sanitary design was selected to improve the patient's oral hygiene.[6,27] The crown was also made with a slight inclination of cusps, a narrower occlusal table, and light contact with opposing teeth. Contact occlusion has also been reported to have a significant impact on the wear process. Therefore, sliding contact during central and eccentric movements should be minimized or largely eliminated when choosing ceramic restorations.[28] The long-term outcomes of several studies have shown favorable results for the hemisection of teeth, with a success prognosis of up to 88%. One study reported a nearly 93% survival rate for hemisection after 10 years of follow-up when a hemisection was performed for the treatment of molars.[29,30] In conclusion, with proper case selection, the hemisection of molars with bifurcation perforation becomes a more conservative treatment option with a favorable long-term prognosis. Socket preservation after a hemisection using bone graft and PRF can enhance the bone healing process.

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DOI: 10.20473/j.djmkg.v58.i1.p100–106

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