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Different extra-coronal restoration options of hemisected teeth on structurally compromised mandibular molar: Report of two cases

Sobrina Mohamed Khazin[1]*, Siti Hajar Omar[2]

[1] *Restorative Dentistry Department, Kulliyyah of Dentistry, International Islamic University Malaysia, Bandar Indera Mahkota, 25200, Kuantan, Pahang, Malaysia.*
[2] *Restorative Dentistry Department, Faculty of Dentistry, Universiti Sains Islam Malaysia, Level 15, Tower B, Persiaran MPAJ, Jalan Pandan Utama, 55100, Kuala Lumpur, Malaysia.*

Abstract

Structurally compromised teeth tend to be extracted due to its their poor prognosis, however, hemisection may serve as an alternative option in selected cases. This case report is aimed to discuss two cases of hemisected mandibular molars with two different approaches for post-hemisection restoration. Case 1 presents with terminal tooth 37 diagnosed with a cracked tooth involving severe bone loss on the mesial root. The tooth was hemisected and restored with a mesially cantilevered full ceramic crown. Case 2 presents with root caries on an endodontically treated tooth 46 on a patient with bruxism, with an inadequate ferrule on the distal segment. The tooth was hemisected utilizing the socket preservation technique, and the tooth was restored with a conventional fixed-fixed bridge with a second abutment on tooth 47.

Keywords: *cracked teeth, mesially cantilevered bridge, root caries, socket preservation*

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***Corresponding author**
Address:
Restorative Dentistry Department, Kulliyyah of Dentistry, International Islamic University Malaysia, Bandar Indera Mahkota, 25200, Kuantan, Pahang, Malaysia
Telephone: +6013-9487099
Email address:
sobrina@iium.edu.my

Introduction

Mandibular molar teeth may have their furcation area or one of its roots severely compromised by caries, periodontal disease, or tooth fracture. Such compromised teeth are often extracted and replaced by fixed or removable prostheses or single tooth implant. However, root resection can serve as an alternative treatment to extraction in selected cases.

Hemisection is a type of root resective procedure that involves the removal of one or two unrestorable roots together with the corresponding coronal structure of a multi-rooted tooth. Hemisection is indicated for teeth with endodontic failures, vertical root fracture or non-restorable portion of a multi-rooted tooth (Ng & Gulabivala, 2014). Despite this available treatment option, the effectiveness of this approach has been questioned. The majority of the failure of this

approach is due to endodontic and restorative components (Gulabivala & Ng, 2014). Hence, multiple factors need to be considered prior to restoring such compromised teeth which is discussed in this article.

Case Report 1: Hemisection of the mesial segment of tooth 37 and restored with a mesial cantilever bridge

A 42-year-old gentleman presented with pain upon biting on his lower left second molar (tooth 37) which was temporarily restored 1 year ago at the outpatient clinic. Clinically, it was noted that there were fractured temporary restoration with secondary caries, tenderness to vertical percussion, 10mm periodontal probing depth on the mid-buccal pocket with class II furcation involvement with other sites less than 3mm probing depth, and no mobility. Upon investigation, the offending tooth did not respond to the cold test (Endo Frost, Roeko, Langenau, Germany) and electric pulp test (Digitest™ Pulp Vitality Tester, Parkell Inc., New York, USA), responsive on the bite test using tooth sleuth on mesiobuccal cusp, and transillumination showed evidence of crack on mid-buccal surface. Radiographically, there were J-shaped radiolucency on periapical of mesial root extending to the furcation area and periapical radiolucency on the distal root (Figure 1). Generally, the patient has a healthy periodontium. Tooth 37 was diagnosed with pulpal necrosis with symptomatic apical periodontitis associated with a cracked tooth.

Figure 1. Pre-operative radiograph of tooth 37 showing radiopacity on the occlusal indicating restoration in close proximity with the mesial pulp horn. Presence of radiolucency mesial to the restoration above the alveolar bone. Presence of J-shaped radiolucency radiolucency on the mesial root involving the furcation area. Presence of periapical radiolucency on distal root.

Non-surgical root canal treatment (NSRCT) was commenced under local anaesthesia; an inferior alveolar nerve block was given using Mepivacaine hydrochloride (2% Scandonest) and rubber dam was applied. Visually, the procedure was aided with a dental operating microscope (DOM) OPMI® pico (Carl Zeiss, Inc, Oberkochen, Germany). Temporary restoration and carious lesion were removed, and the access cavity revealed three distinct root canal orifices. A metal band was placed to stabilize the crack and a crown build-up was done using composite restoration. NSRCT was proceeded, all three canals were obturated with gutta percha and AH-plus sealer (Dentsply Mailelefer, USA) using warm vertical compaction technique and composite core placed 2mm apical to the orifices (Figure 2). The tooth was reviewed after 1-month, however, symptoms persisted with no improvement of periodontal probing depth.

Surgical hemisection of the mesial segment of the tooth was performed, via raising a full thickness envelop flap from the mesial of tooth 36 and releasing incision distal to tooth 37 (Figure 3A). Long tapered fissure bur was used to section the crown vertically

at the furcation area. The mesial segment was elevated and extracted using forceps. Post-operative radiograph was taken (Figure 3B) to assess the hemisected surface of the remaining tooth segment for root spurs or overhanging dentine (Ng & Gulabivala, 2014). The overhanging dentine was trimmed and osteoplasty was performed at the furcation area to get a 4mm distance from the crown margin to the alveolar bone crest. The flap was re-approximated using vicryl 5/0. At 6 months review, tooth 37 showed no symptoms and evidence of healed soft and hard tissues (Figure 3C-D). The edentulous space was replaced with a mesial cantilever full-ceramic crown on the remaining distal segment of tooth 37 (Figure 4A-B). The mesial cantilever was designed with reduced occlusion and large proximal mesial contact. The tooth was reviewed for up to one year, and despite the mesially tilted distal root, the tooth remained asymptomatic and functional (Figure 4C).

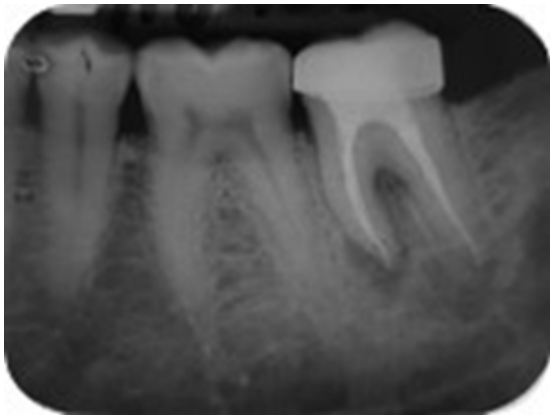

Figure 2. Immediate post-operative radiograph of tooth 37. Showing evidence of radiopacity on occlusal indicating the metal band to stabilize the crack. Composite core were evident in the pulp chamber with no gap at the root filling material. Obturation appears to be well condensed to the radiographic apex with slight root canal sealer extrusion on both roots. No changes in the radiolucency on both mesial and distal roots compared to pre-operative radiograph.

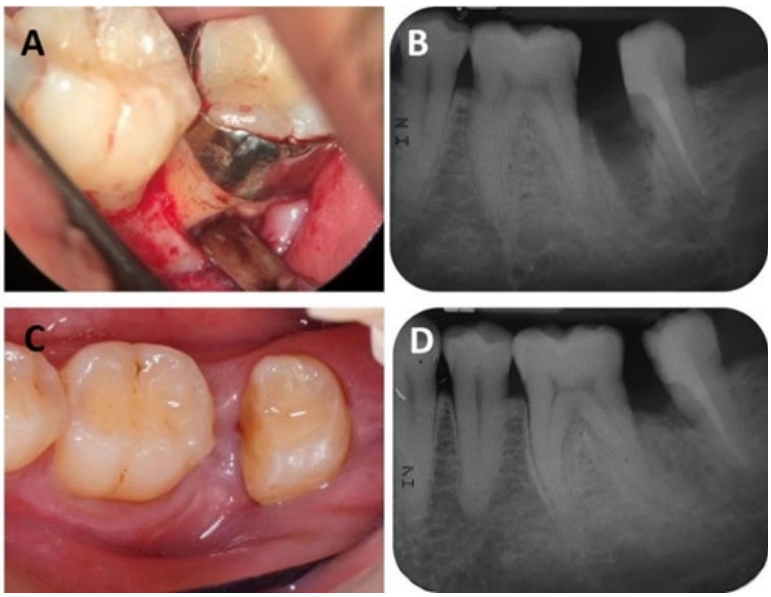

Figure 3. Hemisection of tooth 37. A: Envelope flap raised on buccal and lingual gingiva prior to hemisection. B: Post-hemisection radiograph, showing overhanging dentine at furcation area mesial to the remaining tooth segment and absence of periapical radiolucency on the remaining root. C: Clinical photograph 6 months post-hemisection showing healed soft tissure and clean mesial hemisected surface. D: 6 months post-hemisection radiograph showing mesial drifting of the distal tooth segment and healed bony lesion.

Figure 4. Bridge insertion and 1-year follow-up of tooth 37. A: Clinical photograph showing occlusal view of mesial cantilever full ceramic crown with broad mesial proximal contact on pontic. B: Clinical photograph showing buccal view of mesial cantilever full ceramic crown with reduced occlusion on the pontic and broad mesial proximal contact. C: 1 year review radiograph showing no evidence of periapical radiolucency on tooth 37 with no difference in bone level at mesial in comparison with 6 months review.

Case report 2: Hemisection of a distal segment of tooth 46 and restored with a fixed-fixed conventional bridge

A 48-year-old Malay gentleman with a history of bruxism presented with root caries on an endodontically treated mandibular right first molar (tooth 46). Tooth 46 has a large defective disto-occlusal temporary restoration with an overhanging margin on the distal area detected using the sickle-probe that run through the restoration margin and root surface. Tooth 46 has normal periodontal probing depth circumferentially, no mobility, and not tender to percussion. Radiographically, there was a presence of radiolucency underneath the temporary restoration indicates secondary caries and a periapical radiolucency on the distal root. All the roots were root canal treated with presence of voids on mesial roots and short obturation length on distal root (Figure 5). Tooth 46 was diagnosed with previously treated; asymptomatic apical periodontitis associated with distal root caries.

Non-surgical root canal retreatment was performed for the mesial roots followed by a composite core placement. The obturation homogeneity and length appears satisfactory. (Figure 6). The non-surgical root canal retreatment was carried out under local anaesthesia and rubber dam isolation, visually aided with DOM and followed by a surgical hemisection of the distal segment of the tooth. A full thickness envelope flap was raised from distal of 47 to mesial of 45, tooth 46 was sectioned vertically at the furcation area using long tapered fissure bur (Figure 7A). The distal segment was elevated and extracted using root forceps. Osteoplasty was performed similar to Case 1. Collaplug® (Zimmer Dental, USA) was placed in the socket to stabilize the clot (Figure 7B). Post-operative radiograph was taken 3 months after (Figure 7C). The edentulous space was replaced by a 3-unit fixed-fixed conventional bridge on the hemisected 46 (restored as two PFM premolars of porcelain-fused metal) and 47 (full metal) that act as abutments. (Figure 8A). A hard occlusal splint was prescribed to the patient to reduce the muscle activity and at the same time to protect the prosthesis. At 1-year review, teeth 46 and 47 were asymptomatic and radiographically showed an absence of periapical radiolucency (Figure 8B).

Figure 5. Pre-operative radiograph of tooth 46 showing radiopacity on disto-occlusal of the crown indicating restoration. Evidence of radiolucency apical to the restoration at the distal involving the root and in proximity with the distal root canal obturation. Evidence of well condensed obturation material in mesial and distal root canals, but short obturation on distal canal. Presence of radiolucency at periapical area of distal root and furcation area. Evidence of bone loss at distal with crown-root ratio of 1:1 at distal and 1:2 at mesial. The roots appeared to be divergent.

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Figure 6. Immediate post-operative radiograph of tooth 46 showing radiopacity on the disto-occlusal of the crown indicating restoration with good margin. Root canals appeared to be well-obturated. Radiolucency at the periapical area of distal root and furcation area are still evident.

Figure 7. Hemisection of tooth 46. A: Envelop flap raised and tooth sectioned to half vertically at the furcation area. B: Distal segment was extracted and socket placed with collaplug. C: 3 months post-hemisection radiograph showed healed socket with bone recession on distal.

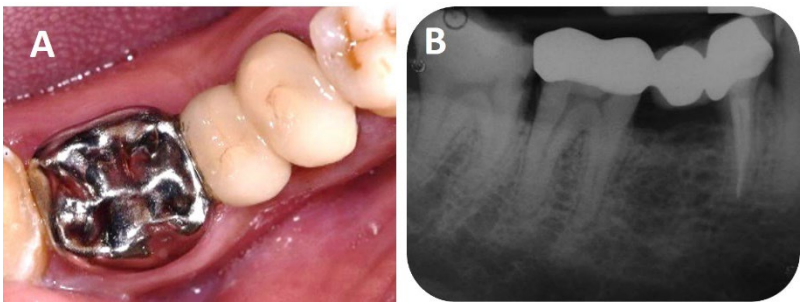

Figure 8. Bridge insertion and 1-year follow-up for tooth 46. A: Occlusal view of fixed-fixed bridge with full metal on abutment tooth 47 and porcelain-fused metal on hemisected tooth prepared as two premolars. B: 1 year review radiograph, showing no evidence of periapical radiolucency on both 46 and 47. The margins of the bridge appeared intact.

Discussion

Crack and dental caries extending to the root often present with restorative treatment challenges. In such cases, periodontal involvement is a frequent sequelae (Banerji et al., 2010), which further complicates treatment modality. However, periodontal intervention were not prescribed for both of the cases. For Case 1, the deep probing depth and furcal involvement was not due to primary periodontal disease but due to cracked tooth. In the case of cracked tooth, when symptoms persisted after endodontic treatment, the tooth requires either extraction or resective surgery (Kahler, 2008). For Case 2, there was no periodontal involvement to indicate periodontal intervention.

Both cases have a poor prognosis considering the periodontal probing depth of more than 5mm with furcal involvement (Olivieri *et al*., 2020), as presented in Case 1 and subgingival root caries with unfavourable crown-to-root ratio (American Association of Endodontists, 2017), as presented in Case 2. Surgical hemisection was opted instead of extraction for both cases, to preserve the natural teeth in the oral cavity, postponing implant placement to later stages.

Prior to hemisection, endodontic treatment is indicated in both cases reported. Tooth 37 in Case 1 was diagnosed with pulpal necrosis which is indicated for root canal treatment, and tooth 46 in Case 2 required endodontic re-treatment due to the failed restoration, suboptimal obturation, and persistent apical periodontitis. Endodontic treatment should commence prior to hemisection in both cases to improve aseptic technique during endodontic treatment by providing proper isolation and crown build-up (Ng & Gulabivala, 2014). Furthermore, untreatable canals such as calcification or existing mishaps that might hinder adequate chemomechanical debridement of the root canal maybe made aware earlier notifying that hemisection may not be suitable (Green, 1986).

A surgical hemisection can be offered in such compromised teeth and has been shown to have a good long-term prognosis with proper case selection (Figure 9) (Setzer *et al*., 2019). The survival rate of hemisected teeth may range from 79.4 to 100% (Table 1). The difference in survival rate can be due to several factors. According to Lang and Tonetti (1996), there are three factors to to be evaluated: patient-related factor, tooth-related factor, and site-related factor. Park *et al.*, (2009) added another factor which is resection-related factor (Table 2). Several studies have shown that the type of coronal restoration placed on the resected segment play a role in the survival of hemisected tooth (Fugazzotto, 2001; Lee et al., 2012; Megarbane et al., 2018; Park et al., 2009). However, the evidence is not conclusive (Setzer *et al.*, 2019), and the type of coronal restoration should be placed based on individual tooth and clinicians' judgement (Megarbane *et al.*, 2018).

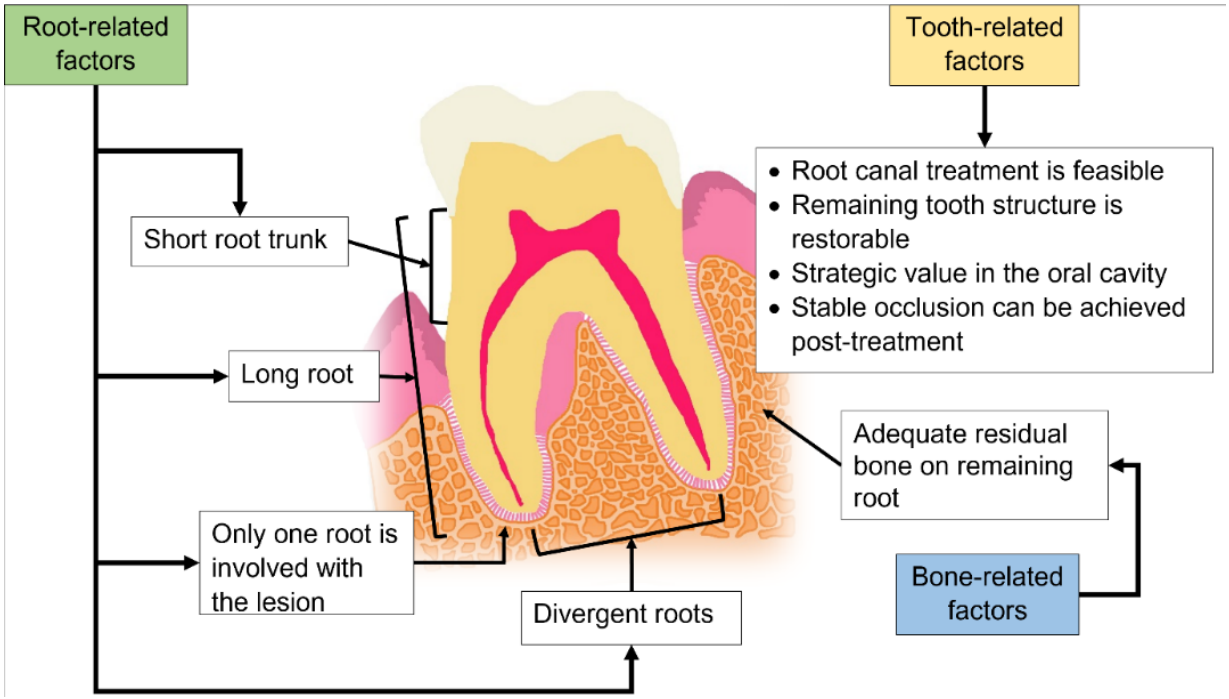

Figure 4. Schematic diagram on indications of hemisection.

Table 1. Overview of study characteristics from the literature on survival rate of hemisected teeth.

Author	Follow-up period (year)	Study design	Sample size	Survival rate (%)
Erpenstein, 1983	1-7	Retrospective	34	79.4
Fugazzotto, 2001	1-15	Retrospective	21	95.1
Zafiropoulus *et al.*, 2009	4	Retrospective	76	80.4
De Beule *et al.*, 2017	1-27	Retrospective	111	82.8
Megarbane *et al.*, 2018	5-40	Retrospective	12	100
Setzer *et al.*, 2019	1-15	Systematic review and meta-analysis	111	81.9

Terminal tooth in general when endodontically treated will have a reduced survival compared to anteriorly located teeth (Ng et al., 2010). The prognosis of a hemisected terminal tooth can be improved when the tooth is restored as an abutment of fixed prosthesis rather than a lone standing terminal tooth (Fugazzotto, 2001) due to the distribution of occlusal forces to the adjacent teeth. The ideal option to restore hemisected tooth 37 in Case 1 would be a fixed-fixed bridge on teeth 37 and 36. However, to include a sound tooth 36 as an abutment for a fixed-fixed prosthesis, there is a risk of compromising it's pulpal health (Mohamed Khazin *et al.*, 2022). Hence, in this case, a mesial cantilevered bridge was placed on the hemisected tooth 37. To compensate for the occlusal load, several modifications to the pontic were undertaken: (1) small pontic (Vujasin *et al.*, 2018), (2) broad mesial proximal contact, and (3) slight under occlusion on the pontic and light contact on the hemisected abutment (Mostafavi & Falahchai, 2017), which can reduce the occlusal stress and improve the survival of the hemisected tooth at the same time preserving the sound tooth 36. Furthermore, the outcome of restoring hemisected molar without splinting to adjacent tooth have similar clinical outcome to single crown implants in the molar area (Schmitz *et al.*, 2019).

Table 2. Factors for survival of resected molars.

Resective-related	Patient-related	Tooth-related	Site-related
• Periodontal reason for resective surgery have higher survival rate compared to resective surgery due to fracture/caries (Park *et al.*, 2009). • Periodontal reason for resective surgery have higher failure rate than other reason for resective surgery (Lee *et al.*, 2012).	• Smoking: impaired healing (Park *et al.*, 2009). • Older patients have higher failure rate than younger patients (Lee *et al.*, 2012; Yuh *et al.*, 2013). • Patients undergoing regular dental check-ups have higher survival rate (Lee *et al.*, 2012). • Patient with diabetes have higher failure rate (Megarbane *et al.*, 2018). • Denture wearers, presence of multiple decayed or filled teeth on other sites have higher failure rate (Lee et al., 2012).	• Resected segment that are splinted to adjacent teeth (bridge) have higher survival rate than single crown or direct restoration (Lee *et al.*, 2012). • No significant difference between the survival rate of resected tooth restored as bridge abutment or as single crown (Megarbane *et al.*, 2018; Park *et al.*, 2009). • Distal root resection without splinting has lower survival rate than mesial root resection (Park *et al.*, 2009). • The use of post have higher failure rate (Lee *et al.*, 2012).	• Pre-operative bone support of >50% at remaining root • have higher survival rate than those with <50% bone support. (Lee *et al.*, 2012; Park *et al.*, 2009). • Pre-operative mobility of Grade II and above have higher failure rate (Lee *et al.*, 2012).

The prosthetic treatment offered to the hemisected tooth 46 reported in Case 2 was a fixed-fixed conventional 3-unit bridge. When the distal segment of tooth 46 is hemisected, the load will be subjected to the remaining slender and curved mesial root with a larger occlusal table compared to tooth 37 presented in Case 1. It has also been shown that a distally cantilevered bridge has the greatest strain upon masticatory load (Vujasin *et al*., 2018), especially on patients with parafunctional habit (Fugazzotto, 2001). Considering the anatomy of the mesial root and the occlusal load, tooth 46 was restored with a fixed-fixed bridge with a second abutment on tooth 47. Furthermore, the buccolingual width of the pontic was reduced to the size of a premolar (Figure 8) (Mostafavi & Falahchai, 2017), and a hard occlusal splint was prescribed to reduce the possible occlusal trauma (Mokbel *et al*., 2019). Tooth 47 was restored with a full metal restoration to lessen the circumferential removal of tooth structure, reducing the risk of pulpal disease (Mohamed Khazin *et al*., 2022) and minimize

the wear of opposing dentition. Metallic materials induce lesser wear on antagonist enamel than the other type of materials because of their low hardness and high ductility properties. The later properties is advantageous in absorbing the occlusal forces (Branco *et al.*, 2020; Choi *et al.*, 2016). Because of the anatomical structure, there is a limited reference on the distal root resection compared to mesial root in mandibular molars.

From the periodontal aspect, the bone level and furcation involvement also play a major determinant in the outcome of hemisected teeth. It has been shown that molars with Class III furcation involvement (McGuire & Nunn, 1996), pre-operative bone support less than 50% (Lee *et al.*, 2012; Park *et al.*, 2009), and pre-operative mobility of grade II or more (Lee *et al.*, 2012) have a poorer prognosis due to large degree of bone loss (McGuire & Nunn, 1996). Moreover, socket preservation (Figure 7B) can also be applied to reduce the bone resorption post-hemisection and maintain the original topography of the alveolar ridge (Mokbel *et al*., 2019).

Comparing the possible outcome of both cases reported in this article, based on the type of coronal restoration, tooth 37 in Case 1 would have a lower survival compared to tooth 46. It has been suggested that resected terminal tooth have lower survival compared to resected intermediate tooth and resected tooth restored as bridge and splinted to adjacent tooth have higher survival compared to single crown or non-splinted resected tooth (Lee *et al.*, 2012). However in terms of mesial or distal root resected, tooth 37 would have a higher survival compared to tooth 46. Studies have suggested that removal of mesial segment of a molar would have better prognosis compared to removal of distal segment (Megarbane *et al.*, 2018). Nonetheless, considering all the modifications made to the treatment of the hemisected teeth, together with the adequate ferrule of 2mm and the presence of more than 50% of bone support on the remaining tooth segment, the cumulative survival rate of hemisected teeth is 81.9% (Setzer *et al*., 2019). Furthermore, the success of hemisected teeth is equivalent to the success of a single tooth implant (Fugazzotto, 2001). Both teeth in Case 1 and Case 2 appeared to be asymptomatic and functional at 1-year review.

Conclusion

Hemisection can be a relevant, practical, and successful treatment option for structurally compromised teeth when proper case selection and prosthesis design are considered, to avoid fracture of the hemisected tooth due to biomechanical impairment. It can also be used as a means to preserve the natural teeth postponing implant placement to later stages.

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Conflict of interest

All author declares no conflict of interest.

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