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Long-term Follow-up of Complicated Crown Fracture With Fragment Reattachment: Two Case Reports

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Clinical Relevance

Complicated crown fracture in permanent teeth may cause restorative problems with an unfavorable prognosis. The fragment reattachment technique is the most conservative treatment option.

SUMMARY

Two cases of complicated crown fracture of the maxillary incisors were restored using the fragment reattachment technique. Root canal treatment was performed, and the fractured fragment was bonded to the tooth structure using a dentin adhesive system and a flowable composite resin, followed by the insertion of a fiber post using dual-cured resin cement. Reattached fragments have shown reliable prognosis without inflammatory signs around bonded junctions after long-term follow-up.

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INTRODUCTION

Approximately 25% of all school-aged children and 33% of adults experience trauma to the permanent dentition.[1] Complicated crown fracture, which means a crown fracture accompanied by pulp exposure, accounts for 2-13% of all traumatic dental injuries.[2-4] The most commonly involved region of complicated crown fracture is the maxillary incisors,[3-5] which presents many challenges to clinicians. Treatment planning and long-term prognosis depend on various factors such as fracture line

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location, biologic width, root development, alveolar bone fracture, soft-tissue injury, occlusion, and esthetics.[2,6] The fragment reattachment technique, first reported in 1964, includes root canal treatment followed by restoration with a cast post and core.[7] Since the advent of adhesive dentistry, the total-etch technique has been applied in fragment reattachment for reinforcement and the retention of fractured tooth fragments.[8,9]

The fragment reattachment technique can preserve the original translucency, morphologic contours, and natural surface textures compared with composite restoration and full-coverage crowns.[10] It is the most conservative and least time-consuming treatment for complicated crown fractures. Previous reports presented successful management of subgingival crown fractures via the adhesive technique and fiber post with a follow-up period of 12 months to four years.[11,12]

Other options to restore complicated crown fractures are surgical crown lengthening, forced eruption, and surgical extrusion.[13,14] Surgical crown lengthening involves osseous and gingival contouring including the adjacent teeth, thereby compromising esthetics and function.[15] Forced eruption requires a treatment period over three months and additional periodontal intervention.[14,16] Surgical extrusion accompanies full-coverage crowns and carries the complications of inflammatory or replacement root resorption.[13,17] Moreover, those three methods cause root length shortening. There have been no randomized controlled trials on the forced eruption and surgical extrusion, yet clinically successful results were reported up to 12-24 months.[13,17,18] The objective of this report is to present two cases of complicated crown fracture using the fragment reattachment method with intracanal reinforcement via a fiber post.

CLINICAL TECHNIQUE REPORT

Case 1

A 15-year-old girl fell at the stairs and visited our emergency center. An oral and maxillofacial surgeon sutured her lacerated upper lip and referred her to the department of conservative dentistry for the treatment of fractured teeth. Complicated crown fractures were visible in the maxillary central incisors (#8, #9), and uncomplicated crown fractures were observed in the maxillary right and left lateral incisors (#7, #10) (Figure 1A,B). The fractured fragments of #8 and #9 were not completely separated from the remaining tooth and exhibited moderate mobility. The fracture line of #8 was supragingival on the labial side and subgingival on the palatal side, whereas that of #9 was located subgingivally on the labial and palatal side. A periapical radiograph revealed obvious fracture lines on #8 and #9 (Figure 1C). For both incisors, root canal treatment followed by fragment reattachment with a fiber post was planned.

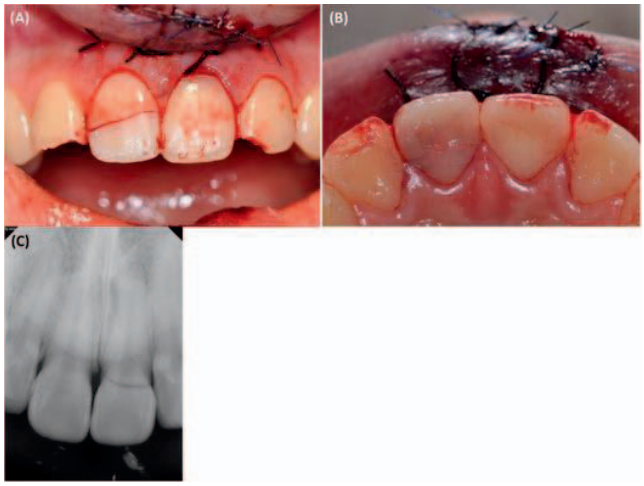

Figure 1. *(A, B) Preoperative photographs of fractured teeth (#8, #9) with complicated crown fractures and #7 and #10 with uncomplicated crown fractures. (C) Intraoral radiograph of fractured teeth.*

At the second visit (one week after the first visit), fractured fragments were removed from #8 and #9. The fragment of #8 was divided into two pieces, and discoloration was observed on the fragment of #9 (Figure 2A,B). On the day the fragment was removed, a single-visit root canal treatment was performed for each central incisor (Figure 2C). The two fractured fragments of #8 were bonded with dual-cure resin cement (Duo-Link, BISCO Inc, Schaumburg, IL, USA) and acetone-based etch & rinse adhesive (One-Step Plus, BISCO Inc). An access hole was made on the palatal side of each fragment to create room for post placement and vent space for the cement spillway (Figure 2D). A slight bevel with 0.5-mm thickness was prepared at the supragingival margin of the fractured teeth and all fractured margins of the fragments. Retention grooves with 0.5-mm depth were made within the fractured fragments (Figure 2E,F). The fractured surface was exposed using flap elevation under local anesthesia. A fiber post (DT-Light Post, BISCO Inc) of the proper size was chosen and adapted after the post space preparation. The fractured surfaces on the fragments, post space, and fractured teeth were treated with 35% phosphoric acid etchant (Select HV Etch, BISCO Inc), and each fragment was bonded to

Figure 2. *(A) Photograph of fractured teeth after removal of the fractured fragments. (B) Fracture fragment of tooth #8 (left) and #9 (right). (C) Intraoral radiograph after root canal treatment. (D) Two segments of fractured fragment of #8 were bonded, and an access hole was prepared on the palatal side of the fractured fragment of #8 (left) and #9 (right). (E, F) Internal dentin groove formed on the fractured fragment of #8 and #9, respectively. (G, H) Reattachment and suturing was performed. (I) Periapical radiograph after reattachment.*

the tooth fractured surface with flowable composite (G-aenial Flo, GC, Tokyo, Japan) and One-Step Plus. Next, the fiber post was cemented using Duo-Link. After careful removal of the excess cement, the flap was sutured with 4-0 nylon silk (Figure 2G-I). The access hole of #8 was restored immediately with

Figure 3. *(A) One-year follow-up photograph and (B) intraoral radiograph. (C) Two-year follow-up photograph and (D) intraoral radiograph. (E) Four-year follow-up photograph and (F) intraoral radiograph.*

composite resin (Estelite Sigma Quick, Tokuyama Dental, Yamaguchi, Japan) and One-Step Plus, whereas that of #9 was filled with temporary filling material (Caviton, GC) for nonvital bleaching (Figure 2H) performed with sodium perborate for two weeks. Two weeks after the reattachment, the wound area exhibited a normal healing appearance, and the colors of teeth #8 and #9 matched the surrounding dentition. The access hole of #9 was restored using the same materials as #8. The vitality of #7 and #10 remained after suture removal, and each was restored with Estelite Sigma Quick and One-Step Plus. One year later, the function and esthetics of the teeth and periodontal tissue were good, and the patient was asymptomatic (Figure 3A). Apical healing of #8 and #9 was examined on a periapical radiograph (Figure 3B). In a visit two years after treatment, the function and esthetics remained good, and there were no pathologic findings on a periapical radiograph (Figure 3C,D).

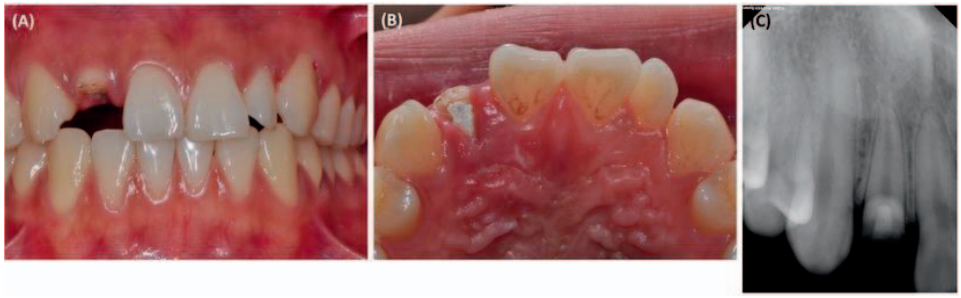

Figure 4. *(A, B) Preoperative photographs of fractured tooth #7 with a complicated crown-root fracture. (C) Intraoral radiograph of the fractured tooth.*

Follow-up checks after four years showed no sign of weakened bonding strength or inflammatory root resorption (Figure 3E,F).

Case 2

A 23-year-old man visited the department of conservative dentistry with the chief complaint of a broken upper anterior tooth. Clinical and radiographic examinations revealed a complicated crown fracture of the maxillary right lateral incisor (#7) (Figure 4A-C). He had fallen down in the street prior to visiting the clinic. A pulp extirpation had been performed on his tooth immediately after the trauma at an emergency center. The patient brought his fractured fragment stored in saline. Root canal treatment followed by fragment reattachment with a fiber post was planned.

After the root canal treatment was completed, the post space was prepared for a DT-Light Post (Figure 5A). An access hole was prepared in the palatal surface of the fractured fragment to create a cement spillway, and a retention groove was made within the dentin to enhance the retention (Figure 5B). Flap elevation was performed on the labial and palatal side under local anesthesia (Figure 5C), and an osteotomy was performed of the palatal side to obtain sufficient biologic width. The fracture surfaces on the fragments, fractured teeth, and post space were treated with a Select HV Etch, whereas the fragment was bonded to the fractured surface with G-aenial Flo and One-Step Plus. Thereafter, the post was cemented using Duo-Link and One-Step Plus, the access hole was restored with composite resin (Charisma Classic, Heraeus Kulzer GmbH, Hanau, Germany), and the flap was sutured with 4-0 nylon (Figure 5D-F). At the four-month follow-up visit, clinical and radiographic examinations showed stable reattachment and periodontal condition (Figure 6A-C). At the five-year follow-up visit, slight discoloration was observed at the cervical area (Figure 6D). However, the clinical and radiographic examinations showed normal function and shape without

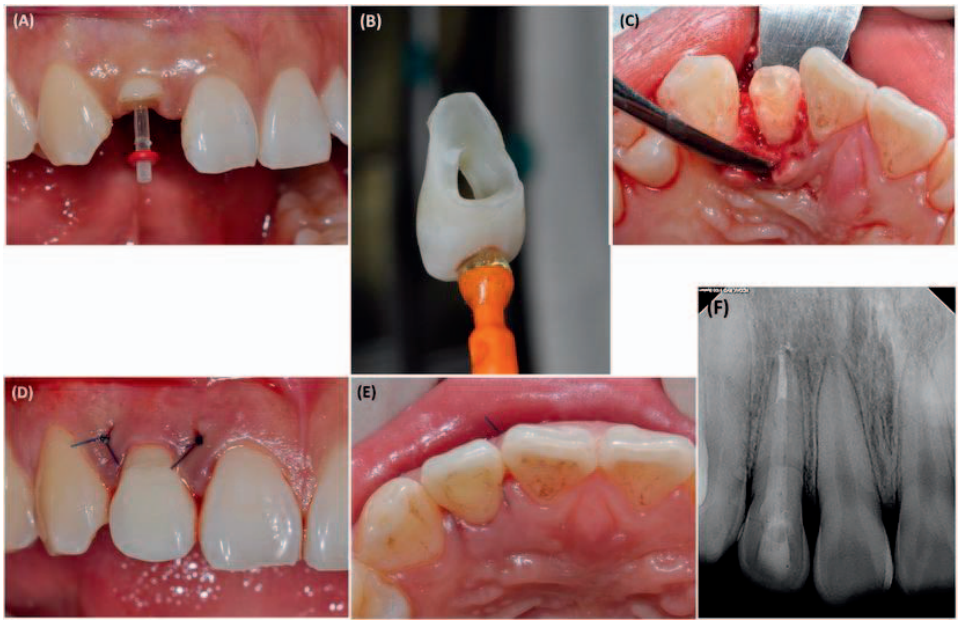

Figure 5. *(A) A fiber post was selected within the post space of tooth #7 after root canal treatment. (B) An access hole was prepared on the palatal surface of the fractured fragment. (C) A palatal flap was raised, and an osteotomy was performed on the palatal side. (D, E) After reattachment and flap suturing and (F) intraoral radiograph after reattachment.*

Figure 6. *(A, B) Four-month follow-up photographs and (C) intraoral radiograph. (D, E) Five-year follow-up photographs and (F) intraoral radiograph.*

weakened bonding or inflammatory root resorption (Figure 6D-F).

DISCUSSION

In both cases, use of the fragment reattachment technique restored the original tooth contour with no signs of gingival inflammation. Even if the reattached fragment would be detached, other treatment methods can be used. Reattachment is the most conservative approach especially in young patients for managing complicated crown fracture.[10]

A fiber post, dual-cure resin cement, and composite core material were used to increase retention and provide a mono-block effect,[11,12,19] which is a gap-free, mechanically homogeneous mass in the root canal space that consists of different bondable materials with similar elastic modulus.[19] A fiber post has some advantages over a cast metal post, such as a similar elastic modulus to that of dentin and high durability.[20,21] It also presents relatively uniform stress distribution to the tooth due to its similar elastic modulus to that of dentin, thereby yielding protection against root fracture.[22,23] Because the establishment of stable adhesion is mandatory for fiber post cementation, Duo-Link and One-Step Plus were used for post cementation. Generally, post space has unfavorable condition for adhesion due to tremendous configuration factor and limited light transmission.[23] One-Step Plus is a total-etch acetone-based dentin adhesive with low acidity (pH 4.6) that shows favorable compatibility with the self-cure composite.[24] Some single-step self-etch adhesives or two-step total-etch adhesives with high acidities showed incompatibility with self-cure composite.[25-26] In addition, the possible contamination during solvent evaporation at the bonded interfaces may be minimized because acetone has a higher evaporation pressure than ethanol or water.[27] G-aenial Flo, which was used to adhere the fractured fragments, is a flowable composite with higher viscosity than other flowable composites. Its use enables the minimizing of excess after fragment adaptation and facilitates excess removal.

The fracture lines in both cases demonstrated an oblique pattern from the labial to palatal side that was unfavorable to bear occlusal forces applied in the labial direction.[28] Nevertheless, both cases showed stable reattachment up to four and five years. The stable reattachment was mainly attributed to proper adhesive procedures.[23,29]

The technique used to increase retention and resistance for reattachment of a fractured fragment includes enamel beveling, a V-shaped internal enamel groove, an internal dentin groove, an external chamfer, and overcontouring.[30] According to Demarco and others, fracture resistance of the reattached coronal tooth structure was increased when a bevel was prepared.[31] De Santis and others

reported that fracture resistance of a reattached bovine incisor was increased when a circumferential chamfer was prepared and filled with composite resin compared with a simple reattachment method.[32] Reis and others demonstrated that overcontouring and an internal dentin groove recovered 97.2% and 90.5% of the fracture resistance for the intact tooth, respectively, whereas simple reattachment recovered only 37.1% and the buccal chamfer recovered 60.6%.[29] Accordingly, an internal dentin groove preparation was used in both cases and enamel beveling was used in case 1.

The palatal fracture margin was located below alveolar bone in case 2, where surgical crown lengthening and an osteotomy were performed to ensure sufficient biologic width. However, such a surgical intervention was not done in case 1, which included a subgingival fracture on the palatal side of tooth #8 and on the labial and palatal sides of tooth #9. Unlike case 2, the fracture lines were located at the same level as the alveolar crest in case 1. When subgingivally placed composite resins received sufficient polymerization and optimal finishing, polishing did not adversely affect the gingiva.[33-35] During follow-up, no gingival inflammation or alveolar bone loss was noted. Polished, planed, and nonirritating subgingival margins in combination with distinct oral hygiene contributed to the prolonged good prognosis in the case of subgingival fracture.[36] This suggests that proper adhesion enables the maintenance of a sound periodontal condition.

CONCLUSIONS

Here we demonstrated fragment reattachment in two cases of complicated crown fracture with esthetic and biocompatible restoration. By using the materials available today in combination with an appropriate technique, predictable esthetic outcomes of crown attachment can be achieved. The use of a fiber post along with adhesive technology may be a sound restorative alternative and less invasive procedure than full-crown coverage.

Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of the Kyung Hee University School of Dentistry, Seoul, Korea.

Conflict of Interest

The authors of this manuscript certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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References

1. Glendor U (2008) Epidemiology of traumatic dental injuries: a 12 year review of the literature *Dental Traumatology* **24(6)** 603-611.
2. Diangelis AJ, Andreasen JO, Ebeleseder KA, Kenny DJ, Trope M, Sigurdsson A, Andersson L, Bourguignon C, Flores MT, Hicks ML, Lenzi AR, Malmgren B, Moule AJ, Pohl Y, & Tsukiboshi M (2012) International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: 1. fractures and luxations of permanent teeth *Dental Traumatology* **28(1)** 2-12.
3. Dame-Teixeira N, Alves LS, Susin C, & Maltz M (2013) Traumatic dental injury among 12-year-old South Brazilian schoolchildren: prevalence, severity, and risk indicators *Dental Traumatology* **29(1)** 52-58.
4. Rajab LD, Baqain ZH, Ghazaleh SB, Sonbol HN, & Hamdan MA (2013) Traumatic dental injuries among 12-year-old schoolchildren in Jordan: prevalence, risk factors and treatment need *Oral Health and Preventive Dentistry* **11(2)** 105-112.
5. Jagannath-Torvi S & Kala M (2014) Restore the natural - A review and case series report on reattachment *Journal of Clinical and Experimental Dentistry* **6(5)** e595-e598.
6. Olsburgh S, Jacoby T, & Krejci I (2002) Crown fractures in the permanent dentition: pulpal and restorative considerations *Dental Traumatology* **18(3)** 103-115.
7. Chosack A & Eidelman E (1964) Rehabilitation of a fractured incisor using the patient's natural crown- case report *Journal of Dentistry for Children* **71** 19-21.
8. Tennery TN (1978) The fractured tooth reunited using the acid-etch bonding technique *Texas Dental Journal* **96(8)** 16-17.
9. Simonsen RJ (1982) Restoration of a fractured central incisor using original tooth fragment *Journal of the American Dental Association (1939)* **105(4)** 646-648.
10. Yilmaz Y, Zehir C, Eyuboglu O, & Belduz N (2008) Evaluation of success in the reattachment of coronal fractures *Dental Traumatology* **24(2)** 151-158.
11. Hegde SG, Tawani GS, & Warhadpande MM (2014) Use of quartz fiber post for reattachment of complex crown root fractures: a 4-year follow-up *Journal of Conservative Dentistry* **17(4)** 389-392.
12. Stojanac I, Ramic B, Premovic M, Drobac M, & Petrovic L (2013) Crown reattachment with complicated chisel-type fracture using fiber-reinforced post *Dental Traumatology* **29(6)** 479-482.
13. Lee J-H & Yoon S-M (2015) Surgical extrusion of multiple teeth with crown-root fractures: a case report with 18-months follow up *Dental Traumatology* **31(2)** 150.
14. Bajaj P, Chordiya R, Rudagi K, & Patil N (2015) Multidisciplinary approach to the management of complicated crown-root fracture: a case report *Journal of International Oral Health* **7(4)** 88-91.
15. Yeh S & Andreana S (2004) Crown lengthening: basic principles, indications, techniques and clinical case reports *The New York State Dental Journal* **70(8)** 30-36.

16. Verma K, Juneja S, Kumar S, & Goyal T (2014) Orthodontic extrusion of subgingivally fractured tooth using a removable appliance: An alternative treatment to reestablish biological width *Indian Journal of Dental Research* **25(5)** 678.

17. Das B & Muthu MS (2013) Surgical extrusion as a treatment option for crown-root fracture in permanent anterior teeth: a systematic review *Dental Traumatology* **29(6)** 423-431.

18. Saito CT, Guskuma MH, Gulinelli JL, Sonoda CK, Garcia-Junior IR, Filho OM, & Panzarini SR (2009) Management of a complicated crown-root fracture using adhesive fragment reattachment and orthodontic extrusion *Dental Traumatology* **25(5)** 541-544.

19. Tay FR & Pashley DH (2007) Monoblocks in root canals: a hypothetical or a tangible goal *Journal of Endodontics* **33(4)** 391-398.

20. Hayashi M, Sugeta A, Takahashi Y, Imazato S, & Ebisu S (2008) Static and fatigue fracture resistances of pulpless teeth restored with post-cores *Dental Materials* **24(9)** 1178-1186.

21. Cagidiaco MC, Goracci C, Garcia-Godoy F, & Ferrari M (2008) Clinical trials of fiber posts: a literature review In: Ferrari M, Breschi L, Grandini S. *Fiber Posts and Endodontically Treated Teeth: A Compendium of Scientific and Clinical Perspectives* Modern Dentistry Media, Wendywood, South Africa 149–163.

22. Cagidiaco MC, Goracci C, Garcia-Godoy F, & Ferrari M (2008) Clinical studies of fiber posts: a literature review *International Journal of Prosthodontics* **21(4)** 328-336.

23. Goracci C & Ferrari M (2011) Current perspectives on post systems: a literature review *Australian Dental Journal* **56(Supplement 1)** 77-83.

24. Sanares AM, Itthagarun A, King NM, Tay FR, & Pashley DH (2001) Adverse surface interactions between one-bottle light-cured adhesives and chemical-cured composites *Dental Materials* **17(6)** 542.

25. Hagge MS & Lindemuth JS (2001) Shear bond strength of an autopolymerizing core buildup composite bonded to dentin with 9 dentin adhesive systems *Journal of Prosthetic Dentistry* **86(6)** 620-623.

26. Cheong C, King NM, Pashley DH, Ferrari M, Toledano M, & Tay FR (2003) Incompatibility of self-etch adhesives with chemical/dual-cured composites: two-step vs one-step systems *Operative Dentistry* **28(6)** 747-755.

27. Yiu CK, Pashley EL, Hiraishi N, King NM, Goracci C, Ferrari M, Carvalho RM, Pashley DH, & Tay FR (2005) Solvent and water retention in dental adhesive blends after evaporation *Biomaterials* **26(34)** 6863-6872.

28. Dean JA, Avery DR, & Swartz ML (1986) Attachment of anterior tooth fragments *Pediatric Dentistry* **8(3)** 139-143.

29. Reis A, Francci C, Loguercio AD, Carrilho MR, & Rodriques Filho LE (2001) Re-attachment of anterior fractured teeth: fracture strength using different techniques *Operative Dentistry* **26(3)** 287-294.

30. Reis A, Loguercio AD, Kraul A, & Matson E (2004) Reattachment of fractured teeth: a review of literature regarding techniques and materials *Operative Dentistry* **29(2)** 226-233.

31. Demarco FF, Fay RM, Pinzon LM, & Powers JM (2004) Fracture resistance of re-attached coronal fragments: influence of different adhesive materials and bevel preparation *Dental Traumatology* **20(3)** 157-163.

32. De Santis R, Prisco D, Nazhat SN, Riccitiello F, Ambrosio L, Rengo S, & Nicolais L (2001) Mechanical strength of tooth fragment reattachment *Journal of Biomedical Materials Research* **55(4)** 629-636.

33. van Dijken JW, Sjöström S, & Wing K (1987) The effect of different types of composite resin fillings on marginal gingiva *Journal of Clinical Periodontology* **14(4)** 185-189.

34. van Dijken JW, Sjöström S, & Wing K (1987) Development of gingivitis around different types of composite resin *Journal of Clinical Periodontology* **14(5)** 257-260.

35. Konradsson K & van Dijken JW (2005) Interleukin-1 levels in gingival crevicular fluid adjacent to restorations of calcium aluminate cement and resin composite *Journal of Clinical Periodontology* **32(5)** 462-466.

36. Frese C, Wolff D, & Staehle HJ (2014) Proximal box elevation with resin composite and the dogma of biological width: clinical R2-technique and critical review *Operative Dentistry* **39(1)** 22-31.