Asian Journal of Periodontics and Orthodontics
2022, Volume 2, Page No: 74-82

Available online at: www.tsdp.net

ISSN: 3062-3499

Original Article

Assessment of Periodontal Outcomes in Anterior Teeth Following Intrasulcular Restorations Using the BAIR Technique

Carina Bona[1]*, Abigail Owusu[2]

[1]Department of Stomatology, Faculty of Medicine and Dentistry, University of Valencia, 46010 Valencia, Spain.
[2]College of Dentistry, Texas A&M University, Dallas, TX 75246, USA.

***E-mail** ✉ Bonacarina.sp@gmail.com

Received: 21 June 2022; **Revised:** 14 October 2022; **Accepted:** 14 October 2022

ABSTRACT

Certain clinical scenarios, such as closing wide diastemas or reshaping malformed, small, or peg-shaped teeth, require adjusting dental proportions along with modifying the gingival contour. Conventional treatment approaches may involve surgical, prosthetic, and/or orthodontic procedures, which can be overly invasive and may not be acceptable to all patients due to the length and complexity of therapy. To address these challenges, the Biologically Active Intrasulcular Restoration (BAIR) technique offers a less invasive alternative, enabling modification of the natural tooth emergence profile through simple intrasulcular direct restorations. This study aimed to evaluate the impact of the BAIR technique on gingival health and patient satisfaction with the aesthetic outcomes. Periodontal parameters were recorded, and patient satisfaction was assessed using a VAS questionnaire. All treated sites healed without complications, no adverse events occurred, and no signs of periodontal morbidity were observed. Patients reported high satisfaction with the aesthetic results and perceived their periodontal health as favorable. The procedure was described as nearly painless, with minimal post-operative discomfort. In conclusion, the BAIR technique represents an effective, minimally invasive alternative for patients unsuitable for conventional treatments, reducing both clinical time and biological and economic costs.

Keywords: Direct restorations, BAIR technique, Composite restorations, Intrasulcular restorations

How to Cite This Article: Bona C, Owusu A. Assessment of Periodontal Outcomes in Anterior Teeth Following Intrasulcular Restorations Using the BAIR Technique. Asian J Periodont Orthodont. 2022;2:74-82. https://doi.org/10.51847/ZuMxBVFttu

Introduction

Aesthetic dental treatments have become a frequent focus in clinical practice [1, 2], driven by the growing demand for facial and smile aesthetics, which has raised patients' expectations for dental interventions [3]. The most common reasons for seeking aesthetic treatment include defects in tooth shape and structure, such as peg-shaped or fractured teeth, as well as diastema closure, often associated with dento-maxillary discrepancies and microdontia. When teeth require an increase in size to maintain balanced proportions, clinical crown lengthening may be necessary; if incisal elongation is not feasible, adjustments must occur cervically, involving interaction with the gingival tissue. Proper management of gingival contours following dental modifications is therefore crucial for successful outcomes.

Treatment planning is often influenced by patient age, as surgical, implant, or prosthetic interventions are generally recommended only for adults who have completed skeletal growth [4]. Consequently, traditional protocols may be unsuitable for younger patients. Beyond age limitations, conventional treatments carry high biological and economic costs, require lengthy procedures, and often involve periodontal surgery for crown lengthening, orthodontics, or prosthetic work. These multi-phase treatments necessitate numerous clinical visits and

extended healing and maturation periods for periodontal tissues [5], which not all patients are willing or able to undertake.

The Biologically Active Intrasulcular Restoration (BAIR) technique [6] offers a potential solution for such cases. It is minimally invasive, can be completed in a single session, and is suitable even for younger patients. The procedure is reversible, often does not require anesthesia, and enables correction of aesthetic defects through direct intrasulcular restorations, allowing modification of the tooth emergence profile and harmonization of surrounding soft tissues [6].

Given these benefits, it is important to assess the safety of the BAIR technique. Historically, intrasulcular restorations have raised concerns regarding potential effects on periodontal health [7–12]. Careful evaluation of possible complications and the response of adjacent soft tissues is therefore warranted. Evidence suggests that, when performed with meticulous technique and supported by good patient hygiene, intrasulcular restorations can integrate seamlessly with the periodontium without inducing inflammation [7–9, 13, 14].

Equally important is evaluating patient satisfaction, which is a primary goal in aesthetic dentistry. Satisfaction depends on aesthetic outcomes, psychological factors, and quality of care, whereas dissatisfaction is often linked to treatment duration, patient neuroticism, and inadequate pain management [15].

The aim of this two-year retrospective controlled study was to compare periodontal parameters of BAIR-treated teeth with those of untreated control teeth within the same subjects and to assess patient-reported outcomes using Visual Analogue Scale (VAS) measures.

Materials and Methods

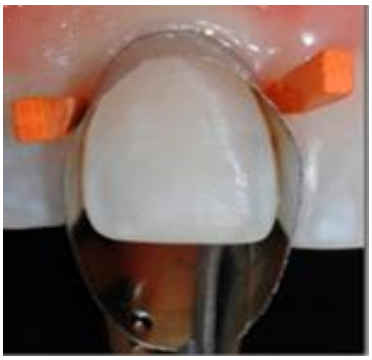
Patient population

This retrospective study examined patients consecutively treated with intrasulcular restorations using the BAIR technique at the Department of Experimental and Clinical Medicine, University of Florence, between June 2019 and January 2020. Patients included required aesthetic correction for anterior maxillary teeth, including peg-shaped or fractured teeth, gingival contour alignment, modification of dental axes, correction of dento-maxillary disharmonies requiring diastema closure, or transformation of teeth due to agenesis or transposition (e.g., canine to lateral incisor, premolar to canine). Written informed consent was obtained from all participants.

Exclusion criteria included: Periodontal Screening and Recording (PSR) > 2 (active periodontal disease), systemic or local conditions affecting periodontal health, ongoing medications influencing periodontal tissues, and smoking more than 10 cigarettes per day.

BAIR technique

The BAIR procedure utilizes a simple circular metal matrix to isolate the operative site, retract soft tissues, and provide clear access to the intrasulcular portion of the tooth **(Figure 1)**. Composite layering allows modification of the emergence angle and reconstruction of an “artificial CEJ.” The intrasulcular composite is polymerized in direct contact with the metal matrix, ensuring a smooth, fully cured surface without oxygen inhibition, eliminating the need for finishing or polishing and avoiding surface roughness that could interfere with periodontal adaptation. The restored emergence profile guides soft tissue positioning. The composite is further shaped in the palatal-vestibular direction using a subtractive modeling technique to achieve the correct volume and contour [6].



a)

b)

c)

Figure 1. a) The matrix is positioned around the tooth, tilted and pressed cervically, held adjacent to the tooth, and slid apically to fit into the gingival sulcus. b) This approach allows effective isolation of the operative field and facilitates application of adhesive and composite. c) The technique enables modification of the emergence angle and reconstruction of a new "artificial CEJ."

Patients were followed for approximately two years, with data collected at three time points: before the BAIR procedure (T0), immediately after the intervention (T1), and at a follow-up roughly two years later (T2).

Periodontal data

Baseline periodontal evaluation included the Periodontal Screening and Recording (PSR) and site-specific variables: Bleeding on Probing (BOP), Probing Depth (PD), and Plaque Index (PI). For BOP and PI, six sites per tooth were assessed, and results were expressed as x/6. PD was categorized into three ranges: <3.5 mm, >5.5 mm, or between these values, measured at six sites per tooth. At the follow-up (T2), a second site-specific evaluation was performed; PD was recorded in millimeters, and BOP and PI were measured for six sites per tooth. Each tooth was assigned a single value corresponding to the worst site measurement, and treated teeth were compared with adjacent untreated control teeth: for central incisors, the lateral incisor served as the control; for laterals, the central incisor; in cases of agenesis or transposition, the adjacent tooth was used; if both central and lateral teeth were treated, the canine was the control. Periodontal measurements were conducted by a calibrated operator (Intraclass Correlation Coefficient [ICC] = 0.87; 95% CI: 0.82–0.91).

Patient satisfaction

Patient-reported outcomes were measured using a Visual Analogue Scale (VAS) questionnaire at T0, T1, and T2. At T0, patients evaluated their perception of anterior aesthetics and gingival health. At T1, additional questions assessed intraoperative pain and stress. At T2, patients reported on aesthetics and gingival health related to the treated teeth. The VAS ranged from 1 to 10, where 1 indicated the lowest and 10 the highest value. Both positively scored outcomes (aesthetics, gingival health) and negatively scored outcomes (pain, stress) were analyzed. Data collection was performed by an operator not involved in the BAIR procedure, while patients completed questionnaires independently; however, responses were not anonymous.

Variables

The primary outcome was PD at the two-year follow-up (T2). Secondary outcomes included complications, BOP (T2), and PI (T2), as well as subjective VAS measures for aesthetics and gingival health in the treated region.

Statistics

Descriptive statistics included mean ± standard deviation for quantitative variables and frequency/percentage for qualitative variables, with the tooth as the unit of analysis. A mixed-effects model was applied to PD at T2, treating the patient as a random effect and treatment group (BAIR or control) as a fixed effect. Similar models were applied for BOP and PI at T2. Changes in VAS scores between baseline and T2 were analyzed using a paired t-test, with the patient as the unit of analysis. Statistical significance was set at $p < 0.05$, and analyses were performed using JMP v.13.0.

Results and Discussion

Twenty patients had undergone BAIR interventions and were initially eligible **(Figure 2)**. Three patients were excluded due to PSR > 2, and one additional patient was excluded because follow-up data were unavailable. Thus, sixteen patients were included, with a mean age of 22.8 ± 14.0 years (range 14.0–64.8), including eleven females (69 percent) and five males (31 percent). One patient was a light smoker (<10 cigarettes/day, 6%), three had treated medical conditions (19%), one had a family history of periodontitis (6%), fourteen had previously undergone orthodontic treatment (87%), two were undergoing orthodontics at the time of study (12%),

and one had abraded incisors (6%). Maximum PSR scores were 0 in 5 patients (31 percent), 1 in 4 patients (25 percent), and 2 in 7 patients (44 percent).

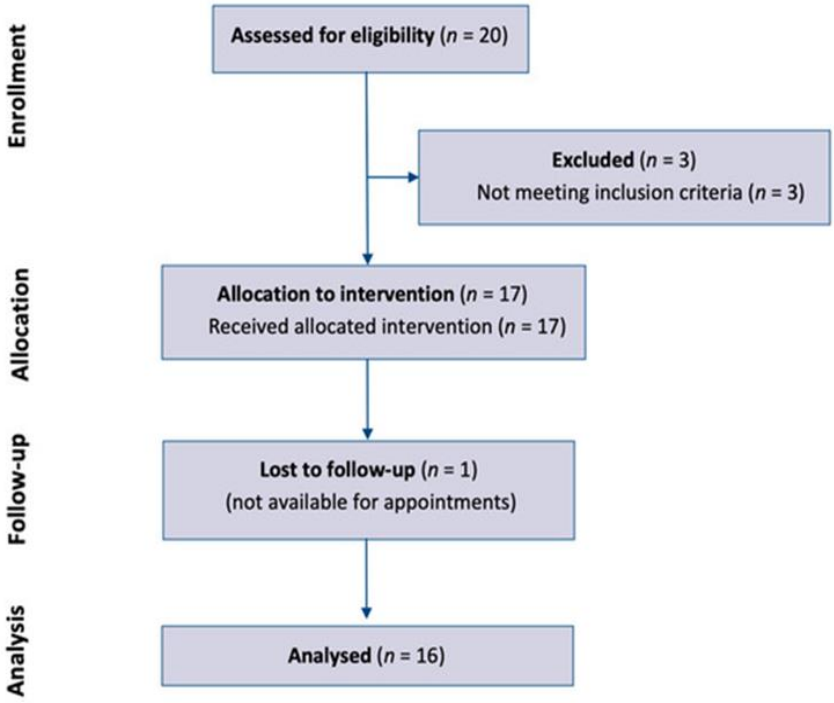


Figure 2. Patient selection process.

A total of 51 teeth were treated, averaging 3.2 ± 1.0 teeth per patient, all located in the maxillary arch: twenty one central incisors (41 percent), 26 lateral incisors (51 percent), 2 canines (4 percent), and two first premolars (4 percent). The study included 32 control teeth (2 per patient), also in the maxillary arch: 11 central incisors (34 percent), 19 canines (59 percent), and two first premolars (6 percent).

Baseline

VAS scores at baseline and immediately after treatment are presented in **Table 1**.

Table 1. VAS at baseline and at treatment.

VARIABLE	*N* = 16
VAS Aesthetics T0	5.0 ± 2.2
VAS Gingival Health T0	6.7 ± 1.8
VAS Intra-op Pain T1	3.6 ± 1.9
VAS Intra-op Stress T1	2.8 ± 1.5

The variables related to the tooth are shown in **Table 2**. PD is less than 3.5 mm for all sites.

Table 2. Variables related to the tooth at baseline.

VARIABLE	*N* = 51
BoP (sites)	0.4 ± 1.0
PI (sites)	0.3 ± 0.7

Follow-up

A two-year follow-up was conducted after the BAIR restorations. All treated sites healed uneventfully, with no complications or adverse events reported by the patients. The mixed-model analysis of periodontal variables is presented in **Table 3**, showing no statistically significant differences.

Table 3. Results at follow-up (T2).

VARIABLE	Treated Group *N* = 51	Control Group *N* = 32	Difference	95% CI	*p*-Value *
PD at follow-up (mm)	2.4 ± 0.6	2.4 ± 0.6	0.1	−0.2; 0.3	0.6777
BOP (sites)	0.4 ± 0.8	0.5 ± 1.0	−0.1	−0.5; 0.3	0.6215
PI (sites)	1.7 ± 1.3	1.4 ± 1.5	0.3	−0.4; 0.9	0.4089

* Mixed models.

The results of the two VAS are shown in **Table 4**. The differences are significant to the advantage of the measurement at T2.

Table 4. VAS results.

VARIABLE	T2 $N = 16$	T2-T0 $N = 16$	95% CI	*p*-Value *
VAS Aesthetics	9.1 ± 1.0	4.1	2.9; 5.3	<0.0001
VAS Gingival Health	8.4 ± 1.0	1.7	0.6; 2.8	0.0045

* Paired *t*-test.

The BAIR technique enables highly satisfactory aesthetic outcomes without the need for periodontal, prosthetic, or orthodontic interventions. Results are achieved quickly, are immediately visible, and require no postoperative healing. The restorations can be adjusted at any time, and the procedure is fully reversible.

The method focuses on altering the tooth's emergence profile through intrasulcular restorations. By creating a new "artificial CEJ," the angle between the crown and root can be modified in both the vestibular–palatal and mesio-distal planes. These adjustments guide the soft tissue positioning, supported by a "shelf" formed by the restoration itself. This approach allows not only for changes in clinical crown length **(Figure 3)** and correction of shape or structural defects **(Figure 4)**, but also for harmonization of the gingival contours **(Figure 5)**, closure of diastema spaces **(Figure 6)**, and "virtual" modification of tooth axis inclinations to enhance the smile and achieve a balanced gingival profile **(Figure 7)**.

a)

b)

c)

Figure 3. a) A woman in her 50s exhibited worn incisors and uneven gingival margins, with tooth 1.1 showing root exposure and carious lesions. To improve aesthetics and "refresh" the smile, the incisors needed enlargement to close the diastema, harmonize the gingival contours, and restore balanced proportions. Traditionally, this would require surgical crown lengthening followed by prosthetic restoration. In this case, the BAIR technique allowed the treatment to be completed in a single session. b) During the intermediate phase, tooth 1.1 was restored; by reshaping the emergence profile and creating a new artificial CEJ positioned more apically, the desired crown length was achieved. c) In the final stage, the BAIR restorations were completed, and the gingival tissues immediately conformed to the newly designed contours.

a)

b)

c)

Figure 4. a) A peg-shaped upper left lateral incisor. b) Treatment was performed using the BAIR technique, with the added composite volume shown in transparency to illustrate the restoration of a normal lateral incisor shape. c) The completed restoration demonstrating the final aesthetic outcome.

a)

b)

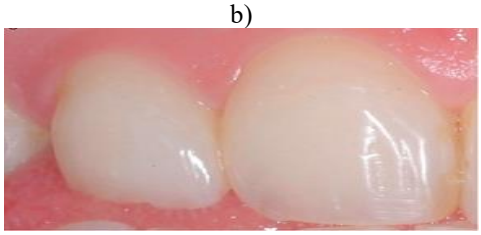
c)

d)

Figure 5. a) A 16-year-old girl at the completion of orthodontic treatment shows a clear size mismatch between the central incisors and the lateral incisors and canines. b) Noticeable diastemas contribute to an unaesthetic smile that the patient found displeasing. c) In a single session, without anesthesia, the microdontic teeth were enlarged, diastemas closed, the vestibular inclination of tooth 2.3 corrected, and the gingival contours harmonized. d) The result is a more balanced and aesthetically pleasing smile.

a)

b)



c)

Figure 6. A 20-year-old man at the conclusion of orthodontic treatment presented with small anterior teeth and wide diastemas (a). To address the patient's aesthetic concerns, the teeth were enlarged using intrasulcular restorations, and contact points were reconstructed to allow the papillae to fill the black triangles (b). Despite suboptimal oral hygiene, the gingival tissues remained healthy (c).

a)

b)

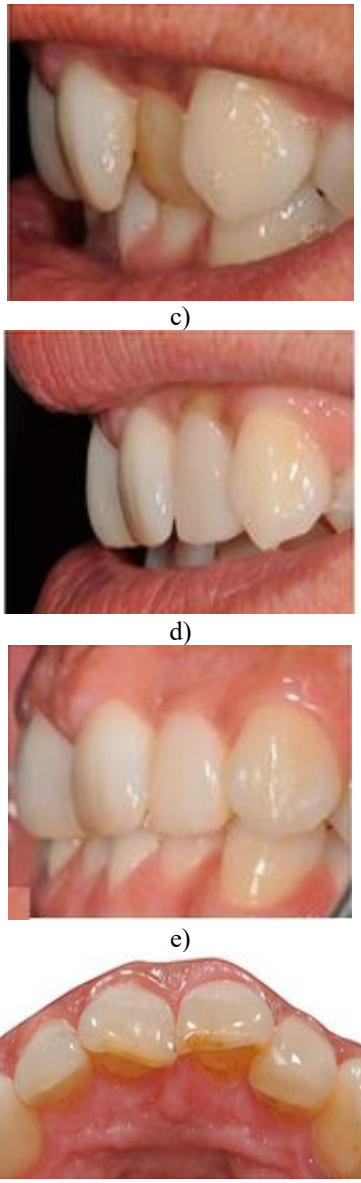


Figure 7. A 37-year-old woman presented with tooth 2.2 tilted palatally (a, c), positioned posteriorly relative to the other anterior teeth, which made oral hygiene more challenging and reduced natural self-cleaning. Consequently, the tooth darkened quickly, causing significant discomfort for the patient, who declined orthodontic treatment. The BAIR technique provided a rapid, minimally invasive, and potentially reversible solution with immediate aesthetic results (b, d). By adjusting the emergence angle in the intrasulcular portion, the lateral incisor could be reshaped to match the contralateral tooth. Follow-up demonstrated a stable outcome (e), with increased tooth thickness (f) that did not cause discomfort, while occlusal relationships remained unchanged.

Regarding intrasulcular restorations, literature reports conflicting views on their potential to induce periodontal damage or inflammation [7–12]. Findings from this study indicate that when performed according to protocol, restorations integrate well with soft tissues without causing gingival inflammation. During the follow-up, no sites exceeded a PD > 3.5 mm, and the gingiva showed no clinical signs of inflammation or patient-reported discomfort. Periodontal measurements at the end of the observation period were comparable to adjacent untreated teeth.

These results align with previous studies [7–9, 13, 14], which demonstrate that subgingival restorations can be performed without provoking periodontal inflammation. Histological studies [16, 17] suggest that epithelial attachment can form on materials such as 4-META/MMA-TBB resin and resin-ionomer restorative materials. Frese [7] reported potential epithelial attachment between resin composite and gingiva, while Dragoo [17] observed both epithelial and connective tissue adhesion between the deep periodontium and resin-ionomer materials. This evidence confirms the biocompatibility of these materials [11, 16, 18], supporting their safe use within the gingival sulcus.

Several factors contribute to the long-term success of intrasulcular restorations. Contact between the composite and the matrix during layering and polymerization prevents oxygen inhibition, ensuring complete curing [6, 19]. The matrix acts as a mold for the apical portion of the restoration, eliminating the need for finishing that could create surface roughness and compromise periodontal health [20, 21]. Proper placement of the matrix also controls humidity and removes the need for a dental dam, which would not allow adequate access or visualization of the most apical margin. However, using devices to retract lips and cheeks is recommended for optimal field control. Consistent oral hygiene remains critical for maintaining long-term success [7, 13].

In addition to evaluating periodontal health, this study aimed to assess patient satisfaction with the intervention. Since all patients were treated for aesthetic concerns, and the maxillary anterior teeth play a central role in smile aesthetics [22], achieving high satisfaction is critical to the overall success of the treatment. The results indicate that patients rated the final aesthetics very positively (9.1 ± 1.0), showing a marked improvement from baseline (4.1). Patients also reported favorable periodontal health (8.4 ± 1.0), perceived the procedure as nearly painless (3.6 ± 1.9), and experienced minimal post-operative discomfort (2.8 ± 1.5).

The high satisfaction scores likely reflect the minimally invasive nature of the BAIR technique. Unlike alternative treatments, it does not require surgery, extensive healing, or anesthesia in most cases, and results are achieved in a single session. VAS data highlight the importance of considering patients' values, expectations, and preferences in routine dental care. While Evidence-Based Dentistry has promoted standardization in recent decades, individualized therapy remains essential to tailor interventions to each patient's specific needs [23–25]. The overall value of an intervention can be viewed as a ratio of "quality" (outcomes, service, safety) to "costs" (financial, biological, time, psychological, and opportunity costs). By minimizing these costs, the BAIR technique enhances overall treatment value. Patient expectations and perceptions of value vary, underscoring the relevance of "Value-Based Dentistry" as an extension of Evidence-Based care to achieve patient-centered outcomes [26].

Another advantage of the BAIR technique is its reversibility. Unlike conventional treatments, it allows for modifications or complete restoration to the original state simply by removing the added composite, offering flexibility when patients are not fully satisfied. Limitations of this study include its observational design and mid-term follow-up. Future research should focus on long-term outcomes, ideally through randomized controlled trials.

Conclusion

The BAIR technique represents an effective therapeutic option for patients who are not candidates for conventional treatments or for whom such treatments are too demanding. It is minimally invasive and reduces operating time, as well as biological and financial costs. Preliminary data demonstrate good integration of the restorations with surrounding periodontal tissues. Long-term evaluation of periodontal outcomes through randomized trials is warranted. VAS results indicate high patient acceptance in terms of aesthetics and perceived gingival health, with minimal discomfort related to pain or stress.

Acknowledgments: None

Conflict of Interest: None

Financial Support: None

Ethics Statement: None

References

1. Machado AW, Moon W, Gandini LG. Influence of maxillary incisor edge asymmetries on the perception of smile esthetics among orthodontists and laypersons. Am J Orthod Dentofacial Orthop. 2013;143(5):658–64.
2. Sriphadungporn C, Chamnannidiadha N. Perception of smile esthetics by laypeople of different ages. Prog Orthod. 2017;18(1):8.
3. Chesterman J, Jowett A, Gallacher A, Nixon P. Bulk-fill resin-based composite restorative materials: A review. Br Dent J. 2017;222(5):337–44.
4. Bohner L, Hanisch M, Kleinheinz J, Jung S. Dental implants in growing patients: A systematic review. Br J Oral Maxillofac Surg. 2019;57(4):397–406.
5. Al-Sowygh ZH. Does surgical crown lengthening procedure produce stable clinical outcomes for restorative treatment? A meta-analysis. J Prosthodont. 2019;28(3):e103–9.
6. Giachetti L. A simple method for modifying the emergence profile by direct restorations: the biologically active intrasulcular restoration technique. Oper Dent. 2020;45(6):575–80.
7. Frese C, Wolff D, Staehle HJ. Proximal box elevation with resin composite and the dogma of biological width: clinical R2-technique and critical review. Oper Dent. 2014;39(1):22–31.
8. Konradsson K, van Dijken JW. Interleukin-1 levels in gingival crevicular fluid adjacent to restorations of calcium aluminate cement and resin composite. J Clin Periodontol. 2005;32(5):462–6.
9. Bertoldi C, Monari E, Cortellini P, Generali L, Lucchi A, Spinato S, et al. Clinical and histological reaction of periodontal tissues to subgingival resin composite restorations. Clin Oral Investig. 2020;24(3):1001–11.
10. Lanning SK, Waldrop TC, Gunsolley JC, Maynard JG. Surgical crown lengthening: evaluation of the biological width. J Periodontol. 2003;74(4):468–74.
11. Ercoli C, Tarnow D, Poggio CE, Tsigarida A, Ferrari M, Caton JG, et al. The relationships between tooth-supported fixed dental prostheses and restorations and the periodontium. J Prosthodont. 2021;30(4):305–17.
12. Nugala B, Kumar BS, Sahitya S, Krishna PM. Biologic width and its importance in periodontal and restorative dentistry. J Conserv Dent. 2012;15(1):12–7.

13. Paolantonio M, D'ercole S, Perinetti G, Tripodi D, Catamo G, Serra E, et al. Clinical and microbiological effects of different restorative materials on the periodontal tissues adjacent to subgingival class V restorations. J Clin Periodontol. 2004;31(3):200–7.
14. Lucchesi JA, Santos VR, Amaral CM, Peruzzo DC, Duarte PM. Coronally positioned flap for treatment of restored root surfaces: a 6-month clinical evaluation. J Periodontol. 2007;78(4):615–23.
15. Pachêco-Pereira C, Pereira JR, Dick BD, Perez A, Flores-Mir C. Factors associated with patient and parent satisfaction after orthodontic treatment: a systematic review. Am J Orthod Dentofacial Orthop. 2015;148(5):652–9.
16. Tsuchiya Y, Muramatsu T, Masaoka T, Hashimoto S, Shimono M. Effect of the dental adhesive, 4-META/MMA-TBB resin, on adhesion and keratinization of regenerating oral epithelium. J Periodontal Res. 2009;44(4):496–502.
17. Dragoo MR. Resin-ionomer and hybrid-ionomer cements: part II, human clinical and histologic wound healing responses in specific periodontal lesions. Int J Periodontics Restorative Dent. 1997;17(1):75–87.
18. Blank LW, Caffesse RG, Charbeneau GT. The gingival response to well-finished composite resin restorations. J Prosthet Dent. 1979;42(6):626–32.
19. Giachetti L. A simple method for treating subgingival class V lesions. Oper Dent. 2019;44(3):333–5.
20. Waerhaug J. Effect of rough surfaces upon gingival tissue. J Dent Res. 1956;35(3):323–5.
21. Litonjua LA, Cabanilla LL, Abbott LJ. Plaque formation and marginal gingivitis associated with restorative materials. Compend Contin Educ Dent. 2012;33(6):e6–10.
22. Sarver DM. The importance of incisor positioning in the esthetic smile: the smile arc. Am J Orthod Dentofacial Orthop. 2001;120(2):98–111.
23. Montori VM. Turning away from industrial health care toward careful and kind care. Acad Med. 2019;94(5):768–70.
24. Pieterse AH, Stiggelbout AM, Montori VM. Shared decision making and the importance of time. JAMA. 2019;322(1):25–6.
25. Richards T, Montori VM, Godlee F, Lapsley P, Paul D. Let the patient revolution begin. BMJ. 2013;346:f2614.
26. Montori VM. Why we revolt: a patient revolution for careful and kind care. Rochester (MN): Mayo Clinic Press; 2017. 174 p. ISBN 978-0999394816.