



Evaluation of the Efficiency of Enzyme-Based Chemomechanical Method in Atraumatic Restorative Treatment of Primary Molars*

Süt Molar Dişlerin Atravmatik Restoratif Tedavisinde Enzim Bazlı Kemomekanik Yöntemin Etkinliğinin Değerlendirilmesi

Merve KOÇ¹ 
kocmerve02@gmail.com

Merve ABAKLI İNCİ^{1**} 
merveabakli@gmail.com

ABSTRACT

Aim: To compare clinical and radiographic successes and pain dimensions of this chemomechanical agent and the traditional Atraumatic Restorative Treatment (ART) method.

Material and Methods: Children aged 3-8 years who applied clinic with their parents were included in our study (n=38). Teeth included study; Traditional ART method with an excavator, enamel chisel and probe and chemomechanical carious tissue removal method with Brix 3000 material was applied. After caries removal methods, restorations were completed with high-viscosity glass ionomer cement (YVCIS). After restoration applications, evaluation was made according to the Wong-Baker Pain Scale. The clinical success restorations were followed up for 3, 6 and 12 months according to the modified USPHS (United States Public Health Service) criteria. Radiographic evaluation was performed in 6 and 12 months. In the whole study, the error value was 5% and the load was accepted maintaining the p<0.05 value.

Results: At 3 and 6 months, there was a difference in marginal compliance criteria between chemomechanical caries removal and YVCIS restorations applied after traditional ART methods, under surveillance (3rd month p=0.040; 6th month p=0.047). YVCIS restorations applied after the chemomechanical caries removal method had Charlie score 2.8% in secondary caries criterion 6th month follow-up. In the evaluation made with Wong-Baker Pain Scale, facial expressions representing "no pain" expression were preferred most both groups. When all results were evaluated between the two groups, no difference was found when removed (p=0.536).

Conclusion: Our study; The chemomechanical caries removal method used non-surgical and acceptable caries removal techniques similar to the conventional ART method.

Keywords: Atraumatic restorative treatment, Brix 3000, Chemomechanical caries removal, Minimal interventional dentistry, Wong-Baker pain scale

Received: 12.06.2023

Accepted: 18.08.2023

Published: 23.08.2023

ÖZ

Amaç: Bu çalışmada kemomekanik bir ajan ile geleneksel Atravmatik Restoratif Tedavi (ART) yönteminin klinik ve radyografik başarıları ve ağrı düzeylerinin karşılaştırılması değerlendirilmesi amaçlanmıştır.

Gereç ve Yöntemler: Çalışmamıza kliniğe ebeveyni ile başvuran 3-8 yaş aralığındaki çocuklar dahil edilmiştir (n=38). Çalışmaya dahil edilen dişlere; ekskavatör, mine keskesi ve sond ile geleneksel ART yöntemi ve Brix 3000 materyali ile kemomekanik çürük doku uzaklaştırma yöntemi uygulanmıştır. Çürük temizleme yöntemlerinin ardından yüksek viskoziteli cam iyonomer siman (YVCİS) ile restorasyonlar tamamlanmıştır. Restorasyon uygulamalarından sonra Wong Baker Ağrı Skalasına göre değerlendirme yapılmıştır. Restorasyonların klinik başarıları modifiye USPHS (United States Public Health Service) kriterlerine göre 3,6 ve 12. aylarda takip edilmiştir. Radyografik değerlendirme ise 6 ve 12. aylarda yapılmıştır. Çalışmanın tamamında hata değeri %5 olarak alınarak p<0,05 değeri istatistiksel olarak anlamlı kabul edilmiştir.

Bulgular: 3. ve 6. ayda kemomekanik çürük temizleme ve geleneksel ART yöntemleri sonrasında uygulanan YVCİS restorasyonlar arasında kenar uyumu kriterinde istatistiksel olarak anlamlı bir fark bulunmuştur (3. ay p=0,040; 6. ay p= 0,047). Kemomekanik çürük temizleme yöntemi sonrasında uygulanan YVCİS restorasyonlar 6. ay takipte sekonder çürük kriterinde %2,8 oranında Charlie skor almıştır. Wong-Baker Ağrı Skalası ile yapılan değerlendirmede iki grupta da en çok ağrı yok ifadesini temsil eden yüz ifadesi tercih edilmiştir. İki grup arasında tüm sonuçlar değerlendirildiğinde ise istatistiksel olarak anlamlı bir fark bulunmamıştır (p=0,536).

Sonuç: Yaptığımız çalışma; kemomekanik çürük temizleme yönteminin, geleneksel ART yöntemi ile benzer şekilde ağrısız ve kabul edilebilir bir çürük doku uzaklaştırma tekniği olduğunu göstermiştir.

Anahtar Sözcükler: Atravmatik restoratif tedavi, Brix 3000, Kemomekanik çürük temizleme, Minimal girişimsel diş hekimliği, Wong-Baker ağrı skalası

Geliş: 12.06.2023

Kabul: 18.08.2023

Yayın: 23.08.2023

Atıf/ Citation: Koc M., Abaklı İnci M. Evaluation of the Efficiency of Enzyme-Based Chemomechanical Method in Atraumatic Restorative Treatment of Primary Molars. NEU Dent J. 2023;5:92-100.

* Bu çalışma danışman Merve ABAKLI İNCİ ve öğrencisi Merve KOÇ'un uzmanlık eğitimi tez çalışmasıdır.

** Sorumlu Yazar/Corresponding Author

1. Necmettin Erbakan Üniversitesi, Diş Hekimliği Fakültesi, Pedodonti Anabilim Dalı, Konya, Türkiye



"This article is licensed under a [Creative Commons Attribution-NonCommercial 4.0 International License](https://creativecommons.org/licenses/by-nc/4.0/) (CC BY-NC 4.0)

INTRODUCTION

Minimal Intervention Dentistry (MID) is a philosophy and approach that aims to keep teeth functional for a lifetime. Since the 1940s, many studies on dental caries, including fluoridation, the use of sugary foods, dental biofilms, adhesive dentistry materials, and repetitive restoration cycles, have taken their place in dentistry.¹ As part of this approach, important strategies are incorporated to prevent caries lesions from occurring, including early detection and assessment of caries risk with the necessary tools, remineralization of demineralized enamel and dentin, anti-caries measures, minimally invasive operative interventions, and restorations that are repaired rather than replaced.²

Atraumatic restorative treatment (ART) is one of the operative minimally invasive treatment techniques that involves the removal of caries containing demineralized enamel and dentin using only hand instruments, followed by restoration of the resulting cavitation with an adhesive restorative material.³ It should be noted that although ART was originally developed for use in underdeveloped societies, it has now become a part of MID in developed countries.⁴ Dental anxiety is one of the most common causes of delayed treatment in dentistry. This indicates that a painless caries removal technique should be used to allow patients to receive dental treatment. The fact that no rotary instrument is used during ART and that it does not require local anesthesia shows that ART is a technique that can reduce the fears and concerns of patients with high anxiety. Moreover, it is also a good alternative for patients with mental or physical disabilities as well as for those who are bedridden.⁵

The advent of chemical mechanical techniques for the removal of caries in the following years revolutionized the field of MID. It is preferred to use these treatment techniques since they remove only the infected dentin without harming the pulp and protect healthy tissues at the same time.⁶ This technique allows the dissolution of denatured collagen in demineralized tooth tissue thanks to the chemical agent used. Thus, carious tissue can be easily removed with hand instruments without the need to apply pressure. A key advantage of this technique is that it is free of pressure, vibration, and sound. This makes it suitable for use in anxious patients.⁷

In 2016, a novel enzyme-based chemomechanical agent derived from the leaves and fruits of green papaya (*Carica Papaya*) was introduced to the market. Marketed as Brix 3000 (BRIX S.R.L./Carcarana, Santa Fe, Argentina), the amount of papain in this agent has been increased to 3,000

U/mg at a concentration of 10%. Papain is bio-encapsulated using EBE (Encapsulated Buffer Emulsion) technology. Through EBE technology, Brix 3000 can reach optimal pH levels for enzyme immobilization. Brix 3000 is distinguished from other agents by the higher papain content and the use of EBE technology.⁸

In the literature, there are a limited number of studies evaluating the pain and clinical follow-up of the chemomechanical caries removal technique using Brix 3000 material. Therefore, in our study, we analyzed hypothesis H0, which assumes that there is no statistically significant difference between chemomechanical caries removal using Brix 3000 material and the conventional ART technique with hand instruments, in terms of clinical and radiographic evaluation criteria and patients' level of pain sensation.

MATERIAL AND METHODS

This study carried out with the approval of Necmettin Erbakan University Meram Faculty of Medicine Clinical Research Ethics Committee dated 12.01.2022 and numbered 2022/734.

Volunteer children between the ages of 3-8 years who applied to the Clinic of the Department of Pedodontics of Necmettin Erbakan University Faculty of Dentistry with their parents were included in our study. Caries removal technique with hand instruments and enzyme-containing chemomechanical agent was applied to the teeth with caries on the occlusal surfaces of the deciduous second molars of the children included in the study and with ART indication. Patients without a systemic disorder (cardiovascular system, endocrine system, central nervous system, etc.) and scored 3-4 on Frankl's Behavior Rating Scale (FBRS) were included in the study.

The minimum number of teeth required for statistical analysis was determined using the G*Power Version 3.1.9.2 software. Accordingly, in order to reveal significant differences between caries removal techniques, a minimum of 66 teeth was determined by selecting the parameters of 0.05 sensitivity, 0.3 effect size, and 81% power. Considering the possibility of case loss due to various reasons during the patient follow-up process, the study was initiated with 38 patients and 76 tooth restorations. USPHS criteria include color match, edge coloring, edge harmony, anatomical form, secondary caries, post-op sensitivity and retention parameters. In the radiographic evaluations, the presence of radiolucency in the periapical and furcal region, the formation of secondary caries and the presence of re-

sorption in the roots were examined (Figure 1). According to the codes, code Alpha and Beta states that the restoration does not need to be renewed, while code Charlie states that the restoration should be renewed. After the restorations were completed, the patient was asked to evaluate using the Wong Baker Pain Scale (Figure 2).

Figure 1: Study design

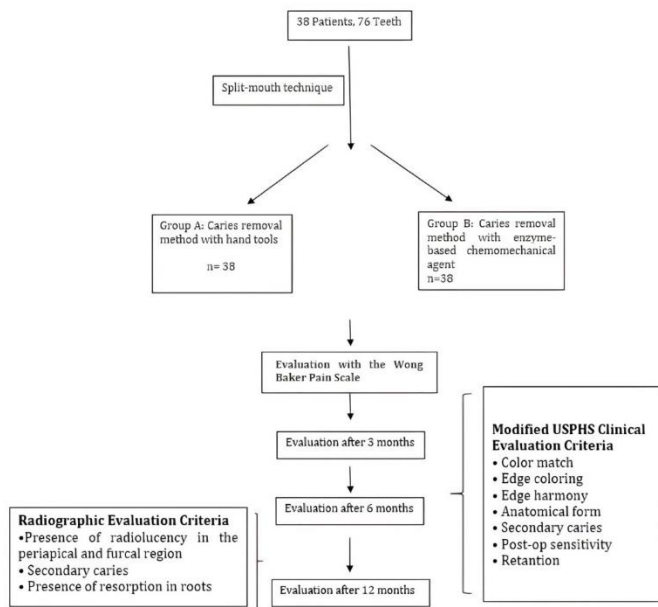


Figure 2: Wong Baker Pain Scale used in the study



Teeth with similar-sized cavitation were selected. We selected deciduous second molars with a caries cavitation depth of at least 2 mm, which did not require the use of rotary instruments (aerator, micromotor) to enter the cavity. Teeth with caries lesions on surfaces other than the occlusal region, preoperative pain or inflammation, and pathologic or physiologic root resorption (more than 1/3) were excluded. Groups were formed by determining the right and left symmetrical teeth of the same patient as 55-65 and 75-85 according to the FDI numbering system using the split-mouth method. Due to the sociocultural and socioeconomic level of the patient population, common caries lesions are seen in patients who apply to the clinic. For this reason, teeth suitable for the desired criteria could not be included in the study in equal numbers in the upper and lower jaws. Randomization was done according to the coin toss method. Restorations are always started from the right side tooth. The chemomechanical agent was applied when it was a coin, and the process was applied with hand tools when it came to heads.

Group A: Application of the Conventional ART Technique

With the aid of cotton rolls, the caries lesion was isolated. The unsupported enamel edges were removed to facilitate access to the cavity with the enamel chisel. After the area within the reach of the excavator was formed, the caries were cleaned by scraping. The caries in the pits and fissures were removed with the help of a probe. In cases where the caries lesion could not be completely removed after the use of the caries indicator, the procedure was repeated. After the completion of the cavity, 37% orthophosphoric acid (Imicryl, Konya/Turkey) was applied to the enamel surface for 20 seconds (sec). Afterwards, the restoration was completed with Riva Self Cure HV and Riva Coat application (Figure 3). The type, content, and manufacturers of the materials used in the study are presented in Table 1.

Table 1: The type, content and manufacturers of the materials used in the study

BRAND NAME	TYPE	CONTENT	PRODUCER
Brix 3000	Chemomechanical Agent	Papain 30000 U/mg 10%	BRIX S.R.L./ Carcarana, Santa Fe, Argentina
Auriga	Excavator	Stainless Steel	Auriga International / Sialkot, Punjab, Pakistan
Saver	Sond	Stainless Steel	Saver / Pakistan
Ocean	Ocean Enamel Chisel	Stainless Steel	Ocean Dental Instruments/ Pakistan
Sablee Seek	Caries Indicator	Glycol Based FD&C Paints	Ultradent / South Jordan, Utah, ABD
Riva Self Cure HV	High Viscosity Glass Ionomer	Fluoro-alumino-silicate glass/ Polyacrylic acid/ Tartaric acid	SDI/ Victoria, Avustralya
Riva COAT	Surface Coating	Acrylic monomer	SDI/ Victoria, Avustralya

Group B: Application of Chemomechanical Caries Removal Method

In accordance with the manufacturer's instructions, Brix 3000 was applied to the isolated caries lesion and then waited for 2 min. Subsequently, with the help of the excavator, the caries removal was carried out without pressure. In the cases where caries lesion removal was insufficient after caries indicator application, the procedure was repeated. After the completion of the cavity, 37% orthophosphoric acid was applied to the enamel surface for 20 sec. Afterwards, the restoration was completed with Riva Self Cure HV and Riva Coat application (Figure 4).

Figure 3: Traditional ART application run **a.** Periapical radiograph of 65 teeth included in the study before the procedure **b.** Intraoral view of tooth number 65 included in the study **c.** Excavator brush removal **d.** Sablee Seek caries indicator application phase **e.** Image after caries indicator **f.** Prepared state of the cavity **g.** Orthophosphoric acid application **h.** After Riva Self Cure HV and Riva COAT application **i.** Post-procedure periapical radiograph of tooth number 65 included in the study

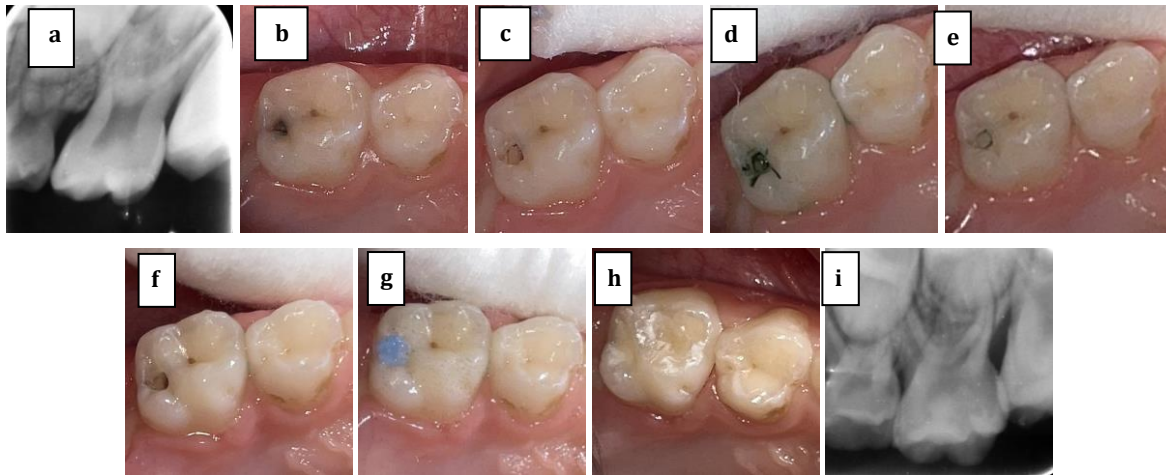
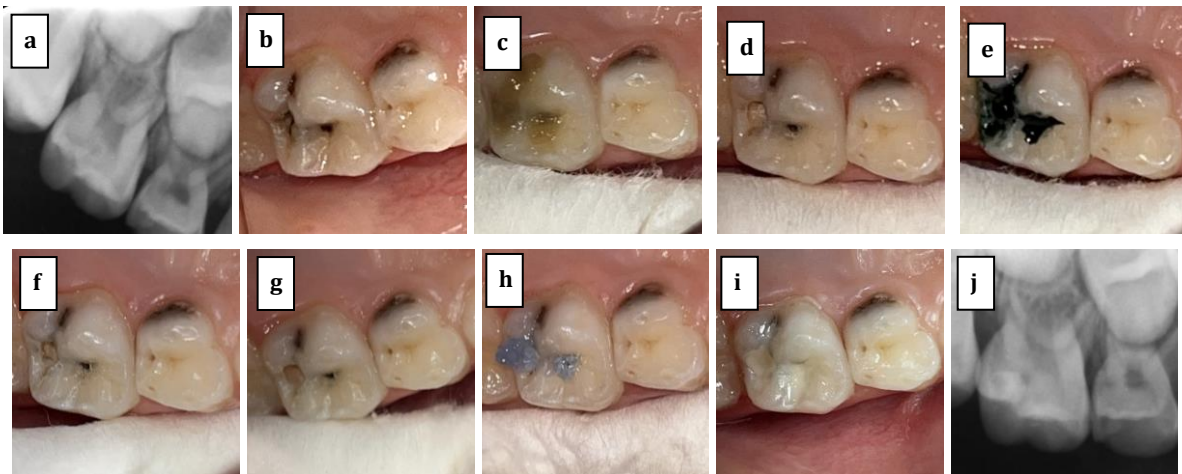


Figure 4: Brix 3000 application steps **a.** Periapical radiograph of tooth number 55 included in the study before the procedure **b.** Intraoral view of tooth number 55 included in the study **c.** Appearance of the chemomechanical agent applied to the tooth **d.** Gentle caries removal with the help of an excavator **e.** Sablee Seek caries indicator application phase **f.** Image after caries indicator **g.** Prepared state of the cavity **h.** Orthophosphoric acid application **i.** After Riva Self Cure HV and Riva Coat application **j.** Post-procedure periapical radiograph of tooth number 55 included in the study



Clinical Evaluations

After the restoration applications, evaluation was made according to the Wong-Baker pain scale. To make pain assessments healthily, only one tooth was treated in each session. Intraoral photographs were taken at 3, 6, and 12 months. Due to the age range of the patient, radiographic control was not performed at the 3rd month; follow-ups were made at 6 and 12 months.

Statistical Analysis

All statistical analyses were conducted using the IBM SPSS version 25 package program. Descriptive and frequency analyses were conducted to evaluate the numerical data.

The Compare Column Proportions Test was used to compare two caries removal techniques applied with high-viscosity glass-ionomer cement

(HVGIC) at 3, 6, and 12 months according to modified USPHS criteria and at 6 and 12 months according to radiological evaluation criteria. Chi-Square Test was used to analyze the same group within each of the periods according to the modified USPHS criteria and radiological evaluation criteria. The Kruskal-Wallis H-Test was used to analyze the distribution of perceived pain levels by age according to the Wong-Baker Faces Pain Rating scale. In the entire study, the error value was taken as 5%, and $p < 0.05$ was considered statistically significant.

RESULTS

Two patients were excluded from the study because they did not come for follow-up visits at the 6th months follow-up of the applied restorations. In the group in which the chemomechanical caries removal technique was applied, 1 tooth was excluded from the study at the 12th month control due

to the observation of secondary caries at the 6th month control.

Clinical Evaluation of the Patients Included in the Study According to USPHS Criteria

When the 3rd, 6th, and 12th months findings were analyzed, the HVGIC restorations applied after chemomechanical caries removal and conventional ART techniques received a high Alpha score in color matching and marginal discoloration criteria. There was a significant difference in marginal adaptation between HVGIC restorations after chemomechanical caries removal and conventional ART techniques at the 3rd and 6th months (3rd month $p=0.040$, 6th month $p=0.047$), however, there was no significant difference at the 12th

month. In the conventional ART technique, the criterion of the marginal adaptation had a higher Alpha score at 3, 6, and 12 months.

HVGIC restorations applied after the chemomechanical caries removal method received a Charlie score of 2.8% in the secondary caries criterion at the 6th month follow-up. In HVGIC restorations applied after the conventional ART technique, secondary caries were not observed in any of the periods. HVGIC restorations applied after chemomechanical caries removal and conventional ART techniques obtained an Alpha score of 100% in postoperative sensitivity criteria in the 3rd, 6th, and 12th months. HVGIC restorations applied after chemomechanical caries removal and conventional ART techniques obtained an Alpha score of 100% on the retention criterion at the 3rd, 6th, and 12th months (Table 2).

Table 2: Evaluation of restorations over all time periods according to modified USPHS criteria

			Chemomechanical caries removal		Traditional ART		p*
			n	%	n	%	
Color match	3 months	A (Alfa)	36	94,7	36	94,7	1,000
		B (Bravo)	2	5,3	2	5,3	
		C (Charlie)	0	0,0	0	0,0	
	6 months	A (Alfa)	33	91,4	34	94,4	0,620
		B (Bravo)	3	8,6	2	5,6	
		C (Charlie)	0	0,0	0	0,0	
	12 months	A (Alfa)	32	91,7	34	94,4	0,633
		B (Bravo)	3	8,3	2	5,6	
		C (Charlie)	0	0,0	0	0,0	
Marginal discoloration	3 months	A (Alfa)	34	89,5	36	94,7	0,395
		B (Bravo)	4	10,5	2	5,3	
		C (Charlie)	0	0,0	0	0,0	
	6 months	A (Alfa)	30	83,3	31	86,1	0,743
		B (Bravo)	6	16,7	5	13,9	
		C (Charlie)	0	0,0	0	0,0	
	12 months	A (Alfa)	26	72,2	23	63,9	0,428
		B (Bravo)	9	27,8	13	36,1	
		C (Charlie)	0	0,0	0	0,0	
Marginal adaptation	3 months	A (Alfa)	34	89,5	38	100,0	0,040
		B (Bravo)	4	10,5	0	0,0	
		C (Charlie)	0	0,0	0	0,0	
	6 months	A (Alfa)	30	83,3	35	97,2	0,047
		B (Bravo)	6	16,7	1	2,8	
		C (Charlie)	0	0,0	0	0,0	
	12 months	A (Alfa)	29	80,6	32	88,9	0,335
		B (Bravo)	6	19,4	4	11,1	
		C (Charlie)	0	0,0	0	0,0	
Secondary caries	3 months	A (Alfa)	38	100,0	38	100,0	-
		C (Charlie)	0	0,0	0	0,0	
	6 months	A (Alfa)	35	97,2	36	100,0	0,314
		C (Charlie)	1	2,8	0	0,0	
	12 months	A (Alfa)	35	100,0	36	100,0	-
		C (Charlie)	0	0,0	0	0,0	
Postoperative tenderness	3 months	A (Alfa)	38	100,0	38	100,0	-
		C (Charlie)	0	0,0	0	0,0	
	6 months	A (Alfa)	36	100,0	36	100,0	-
		C (Charlie)	0	0,0	0	0,0	
	12 months	A (Alfa)	35	100,0	36	100,0	-
		C (Charlie)	0	0,0	0	0,0	
Retention	3 months	A (Alfa)	38	100,0	38	100,0	-
		C (Charlie)	0	0,0	0	0,0	
	6 months	A (Alfa)	36	100,0	36	100,0	-
		C (Charlie)	0	0,0	0	0,0	
	12 months	A (Alfa)	35	100,0	36	100,0	-
		C (Charlie)	0	0,0	0	0,0	

* $p>0,05$

The Radiographic Evaluation of the Patients Included in the Study

The presence or absence of pathology (presence of radiolucency in the periapical and furcal regions,

secondary caries, presence of root resorption) in the teeth included in the study was evaluated radiographically. Considering the radiographic evaluation criteria at 6 and 12 months, no pathology was found in any teeth in either group (Table 3).

Table 3: Distribution of the cases at 6 and 12 months in radiographic follow-ups

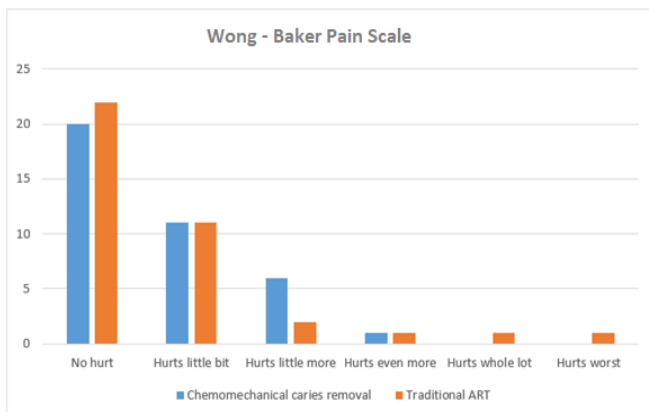
			Chemomechanical caries removal		Traditional ART		p*
			n	%	n	%	
6 months	Presence of radiolucency in the periapical and furcal region	There is	0	0,0	0	0,0	-
		None	36	100,0	36	100,0	
	Secondary caries	There is	0	0,0	0	0,0	-
		None	36	100,0	36	100,0	
	Presence of resorption in roots	There is	0	0,0	0	0,0	-
		None	36	100,0	36	100,0	
12 months	Presence of radiolucency in the periapical and furcal region	There is	0	0,0	0	0,0	-
		None	35	100,0	36	100,0	
	Secondary caries	There is	0	0,0	0	0,0	-
		None	35	100,0	36	100,0	
	Presence of resorption in roots	There is	0	0,0	0	0,0	-
		None	35	100,0	36	100,0	

* p>0,05

The Wong-Baker Faces Pain Rating Scale Assessments in Study Groups

In the assessment of pain level with the Wong-Baker Faces Pain Rating Scale, the facial expression representing the painless expression was preferred most by both groups. When all results were evaluated, no significant difference was found between the two groups (p=0.536) (Graph 1). In the evaluation with the Wong-Baker Faces Pain Rating Scale, there was no significant correlation between the severity of pain and localization of teeth, tooth numbers, age, and gender of patients (p=0.587; p=0.321; p=0.337; p=0.567).

Graphic 1: Wong-Baker Pain Scale evaluation results



DISCUSSION

The fear of the dentist and anxiety associated with dental treatment is among the most significant factors contributing to the avoidance of dental treatments. This situation negatively affects the treatment not only in pediatric patients but also in adult patients with dental phobia. Thus, the need for a painless treatment method that can greatly contribute to routine dental examinations and treatments has emerged. One of the leading principles of modern dentistry, introduced by G. V. Black in the late 1800s, is 'extension for prevention'. In line with this principle, the decayed surface is included in the cavity along with the surface that is likely to decay. As a result, more tooth tissue is removed, as carious tissue does not determine the boundaries of the cavity. In the following periods, with a better understanding of the demineralization-remineralization cycle of caries and the development of adhesive materials, studies moved away from this principle and turned toward MID. In this respect, MID has been revolutionary.

In a study in which carious tissue was removed with ART and cavitations were restored with HVGIC, marginal adaptation was 90.9%, marginal discoloration was 98.7%, and the color match was 43.4% with an Alpha score at 6th month follow-up.

At the 12th month of follow-up, the marginal adaptation was 78.9%, marginal discoloration was 91.5%, and the color match was 45% with an Alpha score. No secondary caries was detected in any of the teeth in the 6th month of follow-up. In the 12th month follow-up, 2.8% of secondary caries were observed.⁹ According to all these results, the H0 hypothesis that there would be no statistically significant difference between the two caries removal methods was rejected in terms of edge fit criterion at 3 and 6 months; was accepted in terms of all other criteria and pain level.

In a clinical trial, Faustino-Silva and Figueiredo¹⁰ also restored the cavities cleaned by the ART technique with HVGIC. In the 4-year follow-up of the restorations, marginal discoloration was 63.1%, marginal adaptation was 78.9%, and the color match was 13.1% with an Alpha score. After 4 years of follow-up, secondary caries was observed in 2.6% of cases.

In our study, similar results were obtained to those reported in the literature. It is noticed that marginal discoloration increases and marginal adaptation decrease with increasing follow-up time. It is of great importance to examine the marginal adaptation of the restorations as it may lead to microleakage in the future. Depending on the nature of the material or the practitioner, the formation of openings along the margin can lead to the accumulation of microorganisms in these areas and ultimately result in pulpal pathologies. Besides, marginal discoloration is also an indication of microleakage and failed restorations.¹¹ As a result of the loss of surface sealant, there may be marginal leakage in restorations. Periodic renewal of the surface sealant is believed to resolve this clinical problem. In the studies, it is seen that the bravo score in color matches increases as the follow-up is prolonged. The researchers reported that this was due to the lack of translucency of glass ionomer cement. Plus, the diet of patients can also cause discoloration in restorations. When the use of restorations in the posterior region is evaluated, it is considered that slight color mismatches can be ignored in terms of aesthetics.¹² The incidence of secondary caries is also similar to studies in the literature. This is explained by the high fluorine release of the GIC material placed after the removal of the carious tissue. The results of a 2011 systematic review also support this view.¹³

In a study evaluating postoperative sensitivity, the levels of sensitivity after chemomechanical caries removal using Brix 3000 material and conventional caries removal techniques were compared on the 8th, 15th, and 30th days. It was reported that there was a significant difference between the

two groups on the 8th, 15th, and 30th days. This difference is thought to occur because, during the use of Brix 3000, the enzymatic gel acts only on the infected tissue and thus does not cause pulpal irritation.¹⁴ Similarly, in our study, no significant difference was found between the two techniques. Both groups had an Alpha score of 100% postoperative sensitivity at all times. It is thought that this rate was reached as a result of preserving the affected dentin while removing the carious tissue and restoring the cavities with HVGIC.

In a 2020 study, pain levels in chemomechanical caries removal and conventional caries removal techniques using Brix 3000 and NaOCl gel materials were compared using the Wong-Baker Faces Pain Rating Scale. A significant difference was found between the pain levels felt in the conventional method and the pain levels in Brix 3000 and NaOCl gel, whereas there was no significant difference between the two chemomechanical techniques. It has been reported that the pain felt by patients is maximized in the conventional method. The researchers attribute these results to the fact that dental anxiety is mainly caused by the injection administered during local anesthesia and the sound and vibration caused by rotating instruments. Chemomechanical agents eliminate these negative factors and increase patient cooperation.¹⁵ Similar results were obtained in the present study as well. After the removal of carious tissue with conventional ART and chemomechanical caries removal techniques, it was observed that patients in both groups preferred "no pain" the most on the Wong-Baker Faces Pain Rating Scale.

In the present study in which pain level was evaluated with the Wong-Baker Faces Pain Rating Scale, score 3 was preferred once during caries removal with Brix 3000, while scores 3, 4, and 5 were preferred once during caries removal with the ART method. In the study by Gupta et al.¹⁶ which was similar to this study, facial expressions corresponding to these scoring were not preferred by any patient in both groups. Taking all evaluations into consideration, the comparison of pain between the two techniques did not demonstrate any significant differences. In both techniques, the level of pain felt by patients is thought to decrease due to the absence of local anesthesia, vibration, and sound factors. Hence, it was concluded that patients did not select expressions representing severe pain.

Nevertheless, the present study has certain limitations. The dense trabecular structure in the mandible causes blood flow and localization to be less than in the maxilla. This can affect the level of pain felt in the jaws. Due to this, one of the most important limitations of the study is the fact that equal

numbers of teeth in the maxilla and mandible were not treated. As stated by the manufacturer, Brix 3000 dissolves carious tissue and facilitates the removal of infected dentin. The contribution of this feature to the shortening of the procedure time could not be evaluated since no time follow-up was performed between the groups during the study. Although it is thought that the high success rate in both techniques is related to the restorative material used and that self-cure HVGIC may be preferred in these techniques, sufficient results could not be obtained since it was not compared with another restorative material. For these reasons, the chemomechanical agent used in our study should be supported by other in vivo studies.

The number of clinical trials with Brix 3000 material, which was introduced in 2016, is limited. In particular, pain level and duration were evaluated in the studies. Our study distinguishes itself from others in that, in addition to pain assessment, a 12th month follow-up of HVGIC restorations applied after the chemomechanical caries removal method was included.

CONCLUSION

Our study demonstrated that chemomechanical caries removal using Brix 3000 material is as painless and acceptable a caries tissue removal technique as the conventional ART technique. It was revealed that the chemomechanical agent used in clinical follow-up did not have a negative effect on color match, marginal discoloration, marginal adaptation, and retention of the restoration. Given these favorable features of chemomechanical caries removal, whether it can replace conventional ART and conventional caries removal techniques in terms of clinical and radiographic success can only be demonstrated by comprehensive in vitro studies and in vivo studies with longer follow-up periods.

Ethics Committee Approval: Ethical approval for this study was obtained by the Necmettin Erbakan University Meram Medical Faculty Clinical Research Ethics Committee (2022/734).

Financial Support: Financial support was received for this study by the Necmettin Erbakan University Dentistry BAP coordinator. (Grant number: 221924002)

Conflict of Interest: The authors deny any conflicts of interest related to this study.

Author Contributions: Design: MAİ, MK, Data collection or processing: MK, Analysis and interpretation: MAİ, MK, Literature review: MK, MAİ, Writing: MK, MAİ

REFERENCES

1. Frencken JE, Peters MC, Manton DJ, Leal SC, Gordan VV, Eden E. Minimal intervention dentistry for managing dental caries – a review: report of a FDI task group. *Int Dent J.* 2012; 62: 223–43.
2. Frencken JE. Atraumatic restorative treatment and minimal intervention dentistry. *Br Dent J.* 2017; 223: 183-9.
3. Mickenautsch S, Yengopal V, Banerjee A. Atraumatic restorative treatment versus amalgam restoration longevity: a systematic review. *Clin. Oral Investig.* 2010; 14: 233-40.
4. Burke FJ, McHugh S, Shaw L, Hosey MT, Macpherson L, Delargy S, Dopheide B. UK dentists' attitudes and behaviour towards atraumatic restorative treatment for primary teeth. *Br Dent J.* 2005; 199: 365–9.
5. Tyrer GL. Referrals for dental general anaesthetics--how many really need GA? *Br Dent J.* 1999; 187: 440-4.
6. Oommen SR, George L, Mathew J, R. V. V, Paul S. Assessment of Pain Response during Caries Removal using Conventional Tungsten Carbide Bur and a Chemomechanical Caries Removal Agent (Brix Gel): An In Vivo Study. *JIDA.* 2021;15:21-7.
7. Ismail MMM, Al Haidar AHM. Evaluation of the efficacy of caries removal using papain gel (Brix 3000) and smart preparation bur (in vivo comparative study). *JPSR.* 2019; 11: 444-9.
8. Lopes MB. Use of BRIX-3000 Enzymatic Gel in Mechanical Chemical Removal of Caries. *J Health Sci.* 2018; 20: 87-93.
9. Menezes-Silva R, Velasco SRM, Bastos RS, Molina G, Honorio HM, Frencken JE, Navarro MFL. Randomized clinical trial of class II restoration in permanent teeth comparing ART with composite resin after 12 months, *Clin. Oral Investig.* 2019; 23: 3623–35.
10. Faustino-Silva D.D, Figueiredo M.C, Atraumatic restorative treatment-ART in early childhood caries in babies: 4 years of randomized clinical trial. *Clin. Oral Investig.* 2019; 23: 3721–9.
11. Aydın N, Karaoğlanoğlu S, Oktay EA, Toksoy Topçu F, Demir F. Diş hekimliğinde bulk fill kompozit rezinler. *Selcuk Dent J.* 2019; 6: 229-38.
12. Gürkan S, Kutuk ZB, Cakır FY, Ergin E. A randomized controlled 10 years follow up of a glass ionomer restorative material in class I and class II cavities. *J Dent.* 2020; 94: 103175.
13. Mickenautsch S, Yengopal V. Absence of carious lesions at margins of glass-ionomer cement and amalgam restorations: an update of systematic review evidence. *BMC Res Notes.* 2011; 4: 58.
14. Varea Torresi F, Freire Acosta M. Estudio comparativo entre el uso de brix-3000 y la técnica convencional rotatoria contra la caries. *Horizonte sanitario.* 2019; 18: 365-71.

15. Alkhoulı MM, Al Nesser SF, Bshara NG, AlMidani AN, Comisi JC. Comparing the efficacies of two chemomechanical caries removal agents (2.25% sodium hypochlorite gel and brix 3000), in caries removal and patient cooperation: A randomized controlled clinical trial. *J Dent.* 2020; 93:103280.
16. Gupta N, Chowdhary N, Reddy VR, Nk K, Peddi R, Kumar M. Evaluation of Caries Removal Efficacy Using BRIX 3000 and Atraumatic Restorative Treatment in Primary Molars: A Clinical Comparative Study. *The JCDP.* 2022; 23: 419-24.