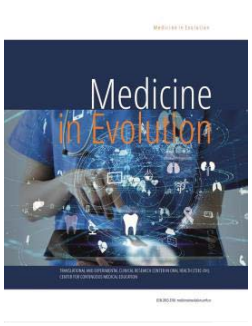
# Minimally Invasive Chemo-Mechanical Treatment Methods Used in Paediatric Dentistry

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## Abstract

Dental caries prevention is one of the main tasks of therapeutic dentistry. Despite this fact dental anxiety in young children is a clinical reality and thus the application of conventional therapeutic protocols is a challenge for any paediatric dentistry specialist.

Pain associated with the therapeutic act of removing a carious process and the use of local anaesthetic agents are still a real problem in pediatric dentistry, concerning anxious patients. For these reasons, we try to create a relaxing environment and perform minimally invasive procedures to increase patient comfort and increase the rate of acceptance of the therapeutic act, especially in the case of anxious and uncooperative children.

The use of chemo-mechanical methods involves the application of proteolytic substances that soften the infected dentinal tissue and allow the selective removal of necrotic tissue using hand instruments, keeping only healthy dental tissue.

The main advantage of this technique is that allows the practitioners to achieve dental treatment without the use of rotary instruments, without generating aerosols and is pain free so, well tolerated by children.

**Keywords:** CMCR, minimally invasive, BRIX3000®, Carisolv®

## INTRODUCTION

The current treatment philosophy is to prevent and a carious lesion at the earliest stage, in order to avoid invasive treatment. With the current understanding of the nature of the carious disease and its process, the treatment philosophy is now changing to a more conservative approach and the concept of minimal intervention is gaining popularity in modern dentistry throughout the world [1].

Dental caries assumes a chronic infectious process, with a multifactorial aetiology involving demineralization of dental hard tissues due to the acidic environment, resulting from the action of bacteria that produces dental plaque on the food carbohydrate substrate [2].

Bacterial plaque represents a micro-aggregate in an organic matrix that is deposited on dental surfaces and other structures in the oral cavity, forming a strong microbial ecological system with intense metabolic activity [3].

In ideal conditions of oro-dental health, the hydroxyapatite in the tooth enamel is in perfect balance with the ions present in the saliva. Through the fermentation process of food hydrocarbons from dental plaque, H* acid ions appear, which causes a decrease in pH below the critical level of 5.5. Hydroxyapatite reacts to acid ions and the balance is disrupted, and the crystalline structure of the enamel undergoes a demineralization process [4]. The demineralization of enamel has as consequences the increase of the interprismatic spaces, the change of the orientation of the hydroxyapatite prisms, changes at the level of the organic matrix, which lead to the increase of the permeability of the dental tissues [5]. At first, the acid attack occurs at the core of the enamel prism, then extends to the walls and finally reaches the superior layer, generating spaces initially by devoiding prisms, spaces that converge and cause the destruction of surface enamel and the appearance of caries that has a rough or cavitary appearance [6].

Tooth decay, also known as dental caries or cavities, may have several different colours from yellow to black [8] and experienced symptoms may include pain and difficulty in eating. Complications may include pulp inflammation, necrosis or abscess, inflammation of tissue around the tooth and finally tooth loss [7,9]. The chemo-mechanical caries removal (CMCR) technique was used to make the treatment more comfortable and easier for both patient and the dental practitioner. Therefore, alternative methods of caries therapy were introduced for the purpose of minimally invasive dentistry without causing pain and over-preparation of dental tissue. These methods are sono-abrasion, air abrasion, ultrasonic, chemo-mechanical systems and lasers [10].

Chemo-mechanical caries removal systems are solutions that act on the principle of carious tissue softening to facilitate their removal, applying enzyme-based agents such as Papain or sodium hypochlorite (NaOCl) [11,12,13].

In 1975, Habib introduced the method of using 5% sodium hypochlorite to remove caries tissue. Many subsequent studies have tried to improve this method because the 5% Sodium Hypochlorite solution has been shown to be toxic and aggressive to surrounding tissues. Therefore, a new solution was developed by adding Sodium Hydroxide, Sodium Chloride and Glycine together with 5% Sodium Hypochlorite. The modified formula was known as GK-101. It was much more effective than 5% Sodium Hypochlorite, which was individually slow in removing carious tissue [14,15].

In January 1998, Chriser Hedwards, Lars Strid in collaboration with a Swedish medical team consisting of Dan Ericson and Rolf Bronstein led to the development of a new caries removal product called Carisolv. Carisolv offers a unique and effective method of removing cavities, leaving healthy tissue intact. Carisolv allows a minimally invasive treatment that selectively softens the affected dental tissue while preserving healthy tissue [16].

In 2004, Carisolv was modified by removing the red colouring agent, decreasing the amino-acid concentration by half and almost doubling the NaOCl concentration from 0.25% to 0.475% [17].

The manufacturer of Carisolv introduced a set of non-cutting tip instruments in order to increase caries removal efficiency and provide maximum conservation of the residual caries-affected dental tissue. The non-cutting tip has a 90° edge that allows a simple scraping movement for caries excavation which cannot be achieved with conventional spoon excavators that cut the dentine in one direction using a scooping motion [18].

In 2016, a new dental product was produced in Argentina that will revolutionize the dental industry called BRIX3000. It is an enzyme-based agent using papain enzyme which has been clinically tested in a broad range of different patients. This formula is non-toxic and has no side effects. It has proven to be safe for contact with skin, eyes and other body parts, and can be used for young children and pregnant women [19].

The enzymatic activity of the bio-encapsulated papain (3.000U/mg) needs only 2 minutes to dissolve any dental tissue that is affected by caries. The enzymatic activity reacts only with dentin that is affected by caries and is considered to be a gentle treatment and needs only a small amount of product [19].

BRIX3000 is in accordance with the atraumatic restorative treatment (ART) technique as considered by the WHO (World Health Organization) and the IDF (World Dental Federation).

Chemo-mechanical solutions seemed to be the best option towards minimally invasive treatments, with good control during application and action and that promotes higher compliance and good treatment experiences for patients of all ages [19, 20].

### *Aim and objectives*

The purpose of this study was to evaluate the caries removal efficacy and patient acceptance for two types of materials BRIX3000 and Carisolv used for caries removal in temporary decayed molars.

## MATERIAL AND METHODS

Two patients, aged 5-7 years, were selected from the casuistry of Paedodontics Department of the Faculty of Dental Medicine, "Victor Babeş" University of Medicine and Pharmacy of Timişoara, based on the following criteria.

**The inclusion criteria for the study were:**

- Subjects aged between 5 and 7 years
- Subjects with dental anxiety
- Subjects with cavitary carious lesions on temporary molars, without pulp complications
- Subjects with cavities that don't need a paedodontic crown restoration
- Subjects with negative percussion test
- Subjects with no periapical or inter-radicular pathology

**The exclusion criteria for the study included:**

- Subjects under the age of 5 and 7 years
- Subjects with systemic diseases
- Subjects with painful carious lesions
- Subjects who present carious primary molars just with enamel affected structure
- Subjects positive to percussion
- Subjects with periapical or inter-radicular pathology
- Subjects who did not agree with the proposed treatment plan

The legal representatives of the subjects completed the patient's informed consent and the medical questionnaire. They were also informed that the answers provided by them will be used in a study, and all personal data are protected by signing the GDPR.

The anamnesis included personal data (age, origin), personal pathological history, dental history, information on current diseases. All these informations were recorded in the patient's file.

**Protocol of BRIX3000**

A five-year-old female patient was brought by her parents in the Paedodontics Department of the Faculty of Dental Medicine, "Victor Babeş" University of Medicine and Pharmacy of Timişoara, accusing painful sensitivity during mastication. After anamnesis and clinical examination, multiple carious lesions were found. At tooth 7.4 there was a class II acute deep carious lesion. On the first appointment, the patient was anxious and uncooperative and we decided to try an expectation approach, so silver diamine fluoride (SDF) was applied on all carious lesions present in the lower arch (Figure 1). At the second visit it was observed that it was not possible to stop the evolution of the 7.4 carious lesion, the dental structure continuing to undermine (Figure 2).

Figure 1. endo-oral view a) right lateral view, b) frontal view, c) left lateral view


Figure 2. class II cavitary carious lesion on 7.4

Absence of abscess and fistula, presence of sufficient dental structure for a direct restoration were also found. A sensitivity cold test was performed as the patient reported pain, getting a positive response. The radiographic examination showed no periapical or inter-radicular pathology. The subject has no systemic diseases and the mother reported that the child was afraid of dentist. Therefore, the chemo-mechanical removal of caries using BRIX3000 papain gel (Brix Medical Science, Carcana, Argentina), was chosen to remove the infected tissue.

The procedure was performed without anaesthesia, under cotton roll isolation (Figure 3) of the operative field, following the principles of ART [21,22].

The papain base gel BRIX3000 was applied to the cavity with a micro-brush allowing the product to work for about 2-3 minutes, avoiding saliva from getting into the cavity which could thin down the gel and prolong the process. After 1 minute, the formation of oxygen bubbles was observed, and the gel turned from translucent to cloudy. The infected tissue was removed through curettage, first at the surrounding walls, using a dentin excavator followed by pulp wall removal of carious tissue (Figure 3).

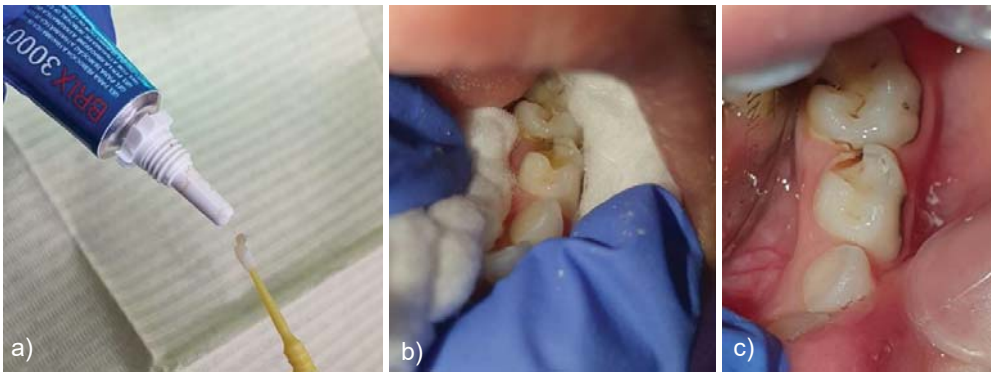

Figure 3. a) chemo-mechanical gel BRIX3000, b) applying the product under cotton rolls isolation, c) dentin surface after the first application

After the gel removal, the cavity was rinsed with water and dried using syringe with mild air blow. According to the manufacturer's guidelines, the product could be applied as many times as required to remove all the infected carious tissue. The product was reapplied, waiting for 2 more minutes, observing the gel colour change and a new curettage was performed. It was observed that after the second application most of the infected tissue had been removed (Figure 4). The cavity was washed with 0,2% Chlorhexidine solution (Gluco-Chex 2 % Cerkamed), to remove dentin residue and then dried with a gentle air jet.

The cavity was conditioned with 10% polyacrylic acid (GC Dentin Conditioner liquid, Tokyo, Japan), which was applied with a micro-brush, allowing it to act for 10s. Both enamel and dentin were washed for 30s and dried. Restorative material (GC Equia Forte Fill) was prepared according to the manufacturer instructions (tap to loosen powder, push the plunger, mix for 10s in amalgamator, click 2 times to prime the capsule and dispense slowly, allow restoration to set 2m30s (from start of mixing), the occlusion was then checked with occlusal mark film (Double check, Swedish Dental Supplies). In the end Equia Forte Coat was applied using a micro-brush and light-cured for 20s (Figure 4).

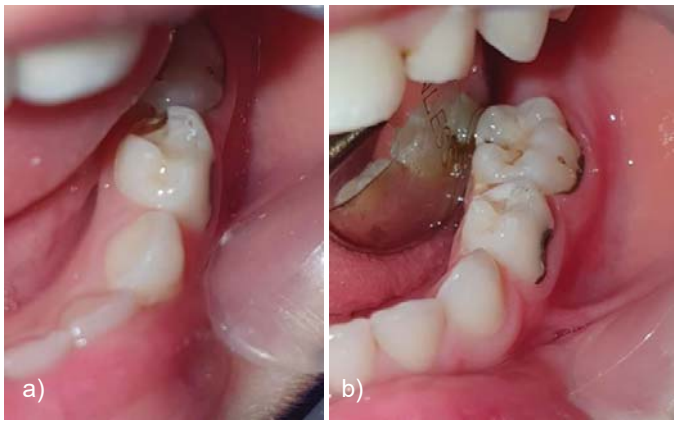

Figure 4. a) view of the cavity after second gel placement, b) final dental restoration

Immediately after the treatment, the child was questioned about the discomfort of the performed procedure using the Wong-Baker Face scale [23] (Figure 5).

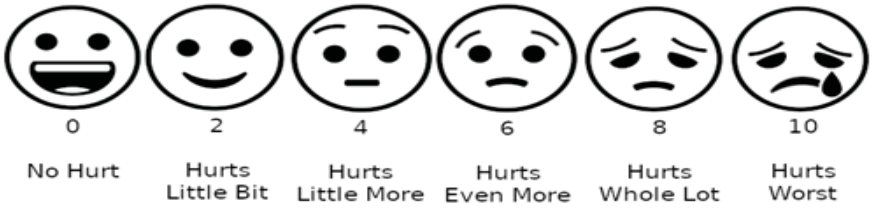


Figure 5. Wong-Baker Face scale

The girl was instructed to point to the picture that represents her level of discomfort after the following question: "*What did you feel during treatment?"* The girl pointed to score 1, that is equivalent to mild pain for treatment.

**Carisolv protocol**

An eight-year-old female patient was brought by her mother in the Paedodontics Department of the Faculty of Dental Medicine, "Victor Babeş" University of Medicine and Pharmacy of Timişoara, with complaints of painful sensitivity caused by cold drinks and sweets. After anamnesis and clinical examination, a class II Angle anomaly was found with bilateral open bite, dental crowding, carious lesions on 1.6, 6.5, 3.6, 8.4, 8.5, 4.6. Early loss of 7.4 and residual tooth roots of 7.5. The patient complains of discomfort and pain generated by the consumption of sweets at the level of 8.5 where a cavitary carious lesion was observed (Figure 6).

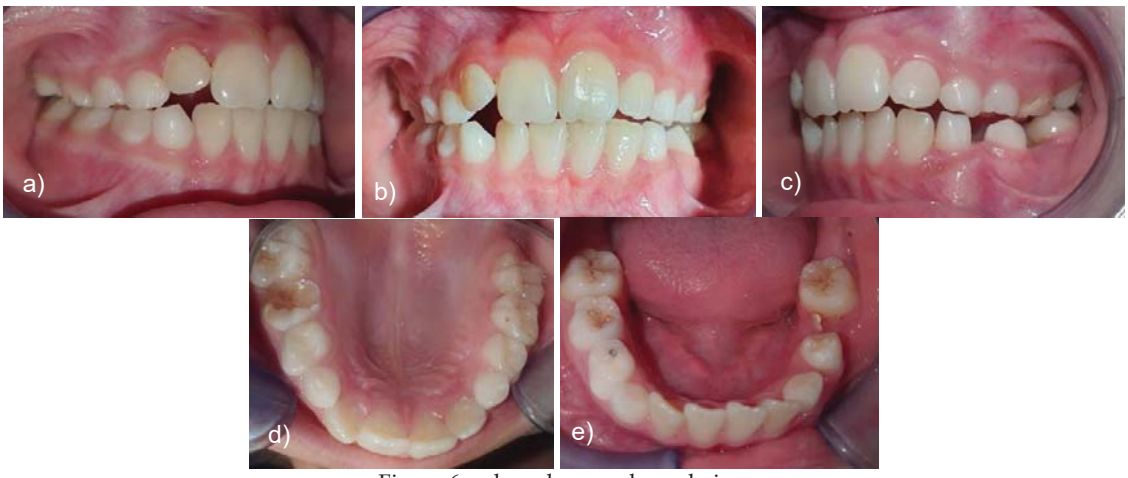


Figure 6. a, b, c, d, e – endo-oral view

Absence of abscess and fistula, presence of sufficient dental structure for a direct restoration were also found. After the sensitivity cold test was performed as the patient reported pain sensitivity, getting a positive response. The radiographic examination showed no periapical or inter-radicular pathology. The subject has no systemic diseases, the mother reported that the child was afraid of the dentist due to traumatic experiences in the past, so she was anxious and uncooperative. Therefore, a CMCR method was chosen to remove the infected dental tissue. In this case, it was used Carisolv and non-cutting instruments (Figure 7).

Figure 7. Carisolv and non-cutting instruments

The procedure was performed without anaesthesia, under rubber dam isolation of the operative filed, following the principles of atraumatic restorative treatment.

The Carisolv product was applied to the cavity with a micro-brush allowing the product to work. After 30 seconds the gel turned cloudy indicating the presence of decayed tissue. To remove decayed dentin, special, non-cutting tools were used to achieve a minimally invasive treatment (Figure 8).

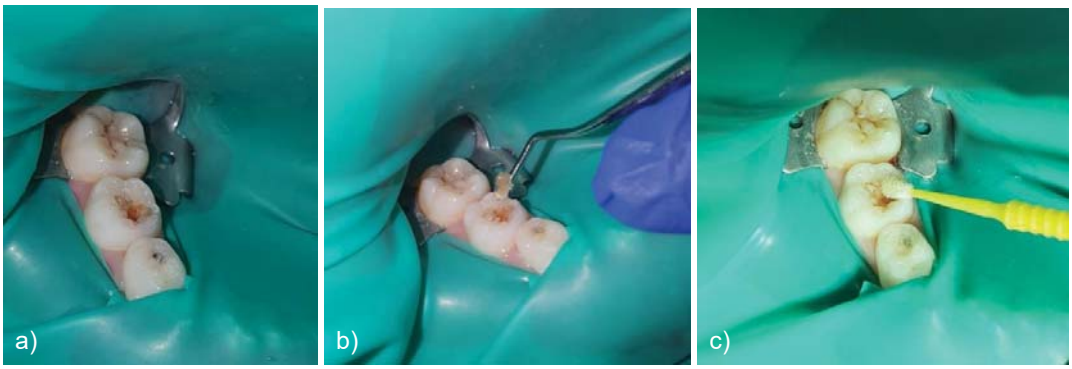


Figure 8. a) class I cavity on 8.5, b) removing the infected dentin with a blunt spoon, c) second application of Carisolv

The cavity is cleaned of cloudy gel and a caries indicator is applied to assess the remaining tissue. Due to the persistence of the infected dentin, a minimum amount of gel is applied again, and mechanical treatment is continued. After removing the entire carious process, the cavity was washed and dried. Then 0,2% Chlorhexidine solution (Gluco-Chex 2 %, Cerkamed) was applied to remove dentin residue. The same direct restoration protocol was then used. After finishing the treatment procedure, the child was questioned about the discomfort of the performed procedure.

The girl was instructed to point to the picture that represents her level of discomfort after the following question: "*What did you feel during treatment?*". The girl pointed to score 1, that is equivalent to mild pain for treatment.

## RESULTS

Following the interpretation of the results obtained through the Wong-Baker Face evaluation scale, no significant differences were observed between the two types of material. The only difference noticed was the discomfort reported by the patient caused by the smell of

Carisolv material due to the presence of NaOCl. The patients said that the treatment was not painful, which increased their compliance, stating that they would return to regular check-ups.

## DISCUSSIONS

Chemo-mechanical techniques have gained acceptance, especially from very anxious, disabled and paediatric patients. It does seem some of these agents would still benefit from quicker excavation times in order to achieve more universal acceptance [24].

Minimally invasive methods are preferable because they preserve more healthy tissue and prolonging the life of the tooth and the undesirable consequences of early extractions, especially in the case of temporary teeth. The concept of minimal intervention not only eliminates the pain associated with removal of caries but also can make a positive attitude in children towards dentistry [5].

The chemo-mechanical agents are the most conservative treatment approach because of their specific action towards decayed dentin.

The chemo-mechanical protocols, even though this method induces less pain in patients compared to conventional mechanical treatment, it is important to acknowledge the tendency for statistically significantly less pain reported when using the enzyme-based agents, as BRIX3000 [20,25]. The conventional methods involve the use of the rotary burs, alone or together with metal hand instruments [26].

The pain and discomfort associated to conventional cavity preparation have led to the reluctance of many patients to seek dental treatment [27]. Besides this, the local anaesthesia, frequently needed to control the pain associated with cavity preparation, is potentially responsible for discomfort and pain [28,29].

Ericson et al. reported that the chemical structure and the mechanism of action of Carisolv were similar to Caridex, except that the monoaminobutyric acid was replaced by three different amino-acids (listed above). The amino acids were shown to react with different of carious lesions. Furthermore, the addition of carboxy-methylcellulose created a higher viscosity of the Carisolv gel, which enhanced its handling properties compared to the Caridex solution. Also, Papacarie was demonstrated to be an effective method of caries removal with less pain, and superior acceptance by patients compared to conventional treatments [20].

## CONCLUSIONS

The use of CMCR methods with both Carisolv and BRIX3000 were easy to use and show high patients' acceptance. It also demonstrates the potential to lead with traumatized, anxious patients, restabilising confidence during dental treatment.

**Declaration of patient consent**

The authors certify that they have obtained all the patient's consent forms. The patient, through his legal representative, consented for his images and other clinical information to be reported under anonymity for medical and scientific research purposes.

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