International Journal of Paediatric Dentistry 2004; **14:** 182–191

Comparison of the efficacy of chemomechanical caries removal (Carisolv™) with that of conventional excavation in reducing the cariogenic flora

B. AZRAK[1], A. CALLAWAY[1], A. GRUNDHEBER[1], E. STENDER[2] & B. WILLERSHAUSEN[1]

[1]*Department of Restorative Dentistry and* [2]*Institute for Dental Material Sciences and Technology, Johannes Gutenberg University, Mainz, Germany*

Summary. *Objectives.* The usage of minimally invasive procedures and attention to patient comfort are of great importance, especially for dental treatment in small children. This has led to the development of chemomechanical methods for caries removal. The aim of this study was to compare the efficacy of chemomechanical caries removal with that of conventional excavation in reducing the count of the cariogenic flora.

Design and setting. Subjects for this study were chosen from children admitted to dental clinic for restorative procedures under general anaesthesia.

Samples and methods. Twenty-one children (mean age 43·5 ± 12·0 months) with early childhood caries were included in this study. Two primary teeth with comparable degrees of carious destruction were chosen in each child ($n = 42$) for caries removal with Carisolv™ or by means of rotary instruments. Samples from carious dentine were taken with a sterile scraping instrument, then all softened dentine was removed and a second sample was taken. All samples ($n = 84$) were serially diluted and plated on two different nutrient agar plates.

Results. After 24 h of incubation, colony forming units were determined for total bacterial counts and lactobacilli. Twelve per cent of the samples from carious dentine contained more than 10^6 bacteria, 23·8% contained more than 10^5 lactobacilli. Both methods of caries removal produced a statistically significant reduction in the bacterial counts ($P = 0{\cdot}0001$). In at least 90·5% of the samples taken after the removal, the total bacterial count was below 10^2, and in 95·2% lactobacilli fell below 10^2.

Conclusion. These results indicate that the efficacy of chemomechanical removal of carious dentine in children by means of Carisolv™ is comparable to the results obtained by conventional methods, and thus might serve as a suitable alternative.

Introduction

In children and patients with dental anxiety, caries removal by means of conventional instruments is often associated with discomfort [1,2]. A possible rise in temperature during excavation, which might cause an irreversible damage to the pulp tissue, poses an additional problem. An alternative method to conventional caries removal by means of rotary instruments, is the use of chemomechanical techniques. This new method of treatment has gained high acceptance especially among children and patients with dental anxiety [3–5]. It can also be applied in patients where the administration of local analgesics is contraindicated, as in 82–92% of the patients no local analgesia is necessary for this technique [3–6]. However, depending on the size of the defect prior

Correspondence: B. Azrak, Poliklinik für Zahnerhaltungskunde, Augustusplatz 2, D-55131 Mainz, Germany. E-mail: azrak@uni-mainz.de

preparation of a cavity in the enamel with high-speed rotary instruments may be needed.

The requirements for a chemomechanical agent used for caries removal include the capability to further degrade partially destroyed collagen [7]; it is thought that the deep layers of the dentine are preserved and only the infected layers will be removed [8]. In the 1970s, Habib *et al*. [9] and Kronman *et al*. [10] studied the effect of a non-specific proteolytic agent, sodium hypochlorite (NaOCl), on carious dentine. This was shown to dissolve not only necrotic organic material, but also affected sound dentine [11]. In order to reduce this aggressive effect, the system was modified [9,12–15].

Further developments eventually led to the new chemomechanical agent Carisolv™ (Medi Team Dentalutveckling AB, Sävedalen, Sweden). In order to improve the efficacy of the agent, monoaminobutyric acid was replaced by three amino acids (glutamic acid, leucine, lysine) and the concentration of sodium hypochlorite was raised [3,7]. In order to reduce the necessary amount of fluid and to obtain a better contact with the tooth surface, the viscosity was increased by the addition of methylcellulose. Several studies have shown that depending on the size of the cavity, caries removal by means of Carisolv™ can take 6·9–13·9 min, and 3·4–6·0 min using rotary instruments [3,6,16]. However, more than 50% of the patients perceived the time needed for the treatment with Carisolv™ as shorter [3]. After treatment with Carisolv™, 90–94% of the cavities were judged caries-free using clinical criteria [3,5,6,16–19]. A microbiological study showed that after treatment with Carisolv™ the cavity floor of primary molar teeth and the root dentine of primary teeth contained only low numbers of microorganisms [20]. Histological studies showed that no irritation or damage was present in the surrounding tissues [21,22]. These investigations also showed no sound dentine had been removed. After the treatment with Carisolv™, a more rapid formation of hard tissue was detected when pulp tissue was exposed to the agent; this was thought to be associated with the high pH value of the agent [23].

From the deepest layer of carious lesions, mainly species of *Actinomyces*, *Bifidobacterium*, *Eubacterium*, *Lactobacillus*, *Propionibacterium* and *Rothia* can be isolated, while in rare cases *S. mutans*, *A. naeslundii* and *C. gingivalis* may invade the dentinal tubules [24]. Hahn *et al*. [25] found two types of carious dentinal lesions: in one a high level of lactobacilli was present and in the second a low level of lactobacilli was associated with a mixed flora.

The aim of this study was to determine the efficacy of the chemomechanical agent Carisolv™ for caries removal from primary molars employing a bacteriological evaluation. The total viable counts and viable counts of lactobacilli, which play an important role in the progression of dentinal caries, were first determined from the infected dentine, and then from the top layers of the residual dentine after caries removal either by conventional or chemomechanical methods. A comparison of the reduction in microbial counts achieved by the two methods was then carried out.

Methods

Two carious primary teeth each from a total of 21 children with early childhood caries, who were treated under general anaesthesia, were chosen for this study. All children (11 girls and 10 boys with a mean age of 43·5 ± 12·0 months) were systemically healthy, showed normal development for age, and had no defects in tooth formation or tooth development. A dental assessment was carried out for all children, and the degree of destruction of the primary molars was determined with a dental probe, using clinical criteria. Two first or second primary molars with brown and softened dentine and having defects with broadly comparable depths (moderate caries or deep-seated caries) from different quadrants were chosen for sample taking. The teeth were assigned to sample or control groups using a random numbers table.

Clinical procedures

Conventional caries removal was carried out employing a spherical bur on a green handpiece (KaVo, Germany), without water spray at 6000–8000 r.p.m. Carisolv™ (MediTeam) was used for the chemomechanical caries removal. Carisolv™ consists of a two-component gel, supplied in two different syringes. The first syringe contains glutamic acid, leucine, lysine, sodium chloride, erythrosin, carboxymethylcellulose, water and sodium hydroxide and has a pH value of 11. The second syringe contains 0·5% sodium hypochlorite and alanine aminotransferase. According to the manufacturer's instructions, both syringes were removed from the refrigerator approximately 1 hour before treatment, and their contents

were mixed shortly before use until a homogeneous colour was obtained. Caries removal was carried out immediately after mixing and took a maximum of 10 min. In this way, the critical time of 20 min was not exceeded, after which, according to the manufacturer's instructions, the efficacy of Carisolv™ begins to deteriorate. The gel was applied to the carious dentine with a round condenser. After 30–60 s the softened dentine was removed with an excavator, without exerting force. Carisolv™ was applied 3–6 times, until the gel no longer turned cloudy with debris. In those cases where there was no sufficient access to the carious dentine, an access cavity was prepared with a high-speed drill. In all cases, the top-most layer of the carious dentine was removed with a diamond bur, and the teeth were dried, so that contamination with bacteria from superficial plaque could be avoided. Removal of the samples from the infected dentine, as well as the actual caries removal by means of the respective methods, took place under absolutely dry conditions in order to avoid contamination with saliva. Before caries removal, the samples from infected dentine were taken with a sterile excavator. To obtain sufficient amounts of sound dentine after caries removal, at least three visible dentine particles were removed. No rinsing took place between Carisolv™ treatment and taking of the samples from sound dentine. After conventional caries removal with a spherical bur, dentine was considered caries-free, using established clinical criteria, i.e. optical and tactile, with a dental probe. When using Carisolv™, the cavities were considered caries-free, when the applied gel no longer turned cloudy, as was recommended by the manufacturer.

Microbial cultivation and evaluation

Immediately after removal, the dentine samples were transferred into a sterile vial with a screw cap and processed in the lab within 2 h. Each sample was mixed with 500 µL sterile isotonic saline and vortexed for about 15 s in order to dislodge the bacteria from the dentine. The samples were then serially diluted and plated on two different agar plates. Schaedler agar (Difco, Detroit, MI, USA) was used to determine the total viable counts and MRS agar (Difco) was used to determine the viable counts of the lactobacilli. The agar plates were incubated anaerobically (BBL GasPak Plus™, Becton Dickinson, Sparks, MD, USA) for 2–3 days (Schaedler at 37 °C, MRS at 32 °C). Then the numbers of colonies were determined and expressed as CFU (colony forming units) per sample. A sample was taken from each colony type grown on MRS agar and examined in a phase contrast light microscope to determine the morphological type of the bacteria. It was confirmed that the bacteria were of regular rod-shape in all cases, which is typical of lactobacilli.

A few of the carious dentine samples were visually evaluated in a scanning electron microscope to see whether bacteria had been able to penetrate into the dentinal tubules and which morphological types could be found. The samples were fixed in 3% formaldehyde for 1 hour, dehydrated by sequential washes through a series of 50–96% graded ethanol baths, and finally dried in air. After sputtering in a cold sputter unit the samples were viewed in a Zeiss DSM 962 scanning electron microscope (Zeiss, Oberkochen, Germany) at an accelerating voltage of 10 keV.

Statistical methods

The data were processed with the aid of SAS 6·12 statistical software at the Institute for Medical Biometrics, Epidemiology and Computer Sciences, employing the Wilcoxon signed rank test for paired samples.

Results

A total of 42 samples of carious dentine from 21 patients (11 girls and 10 boys) were evaluated. The children were 24–70 months old (mean age 43·5 ± 12·0 months). Deep-seated caries was detected in 83·3% of the teeth included in the present study, while the remaining teeth were classified as having moderate caries. The total viable count and viable count of lactobacilli were determined and expressed as colony forming units (CFU) per sample. Because of the wide range of total numbers, six classes were defined for the total viable count (less than 10^2 to more than 10^6, Figs 1 and 4), and five for the viable count of lactobacilli (less than 10^2 to more than 10^5, Figs 7 and 8). In 88·0% of the carious dentine samples the total viable count of bacteria was below 10^6 CFU per sample, while in 12·0% more than 10^6 CFU were found (Fig. 1). Nineteen per cent of the carious samples contained less than 10^3 CFU. The exact values of samples with less than 10^3 CFU and more than 10^6 CFU could not always be determined.

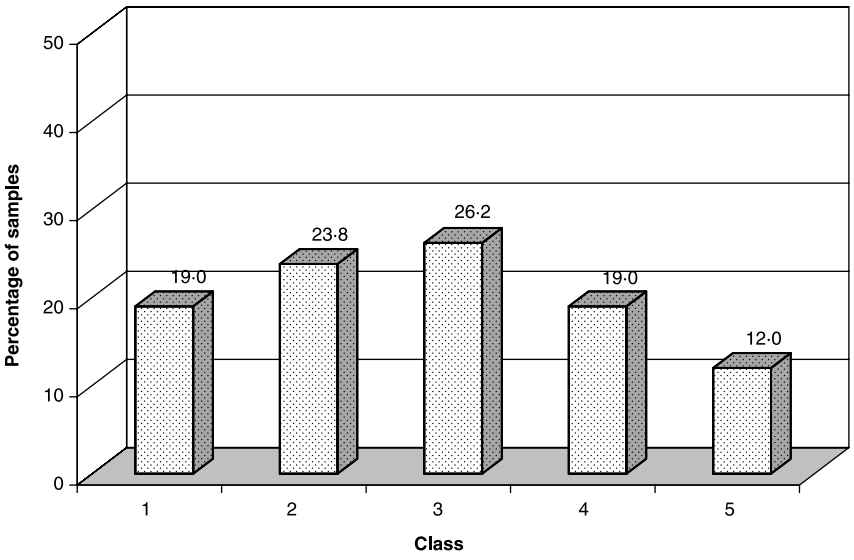

Fig. 1. Percentage of carious dentine samples with a total viable count in class 1: ≤ 10^3, 2: 1001–10^4, 3: 10 001–10^5, 4: 100 001–10^6, 5: > 10^6.

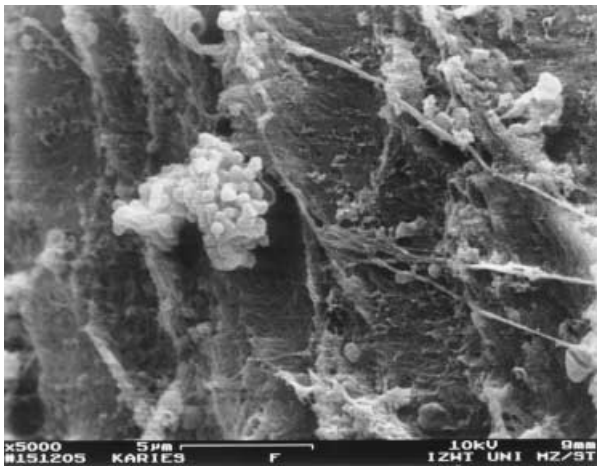

Fig. 2. Scanning electron micrograph of carious dentine from a primary tooth. A microcolony made up of cocci can be seen on the left, while thin filaments adhere to the surface on the right. Bar = 5 µm.

The visual analysis of carious dentine samples by electron microscopy revealed mainly coccal or rod-shaped microorganisms; filaments were observed occasionally. In Figure 2, a microcolony, made up of cocci, can be seen on the left while thin filaments adhere to the surface on the right. Figure 3(a) shows a dentine sample, which is densely populated by mainly rod-shaped microorganisms. In Figure 3(b), where a detail of the same picture is represented at a 10^4-fold magnification, the structures of the colonizing microorganisms can be seen more accurately: rod-shaped microorganisms of various lengths and occasional cocci are present.

After treatment with Carisolv™ as well as with a rotary instrument total viable counts in the clinically healthy dentine were reduced in all samples to values below 10^3 CFU (Fig. 4). Figures 5 and 6 show bacterial colonies grown on Schaedler agar from carious dentine from the same patient (left); various morphological colony types can be seen, differing in size, shape and colour. The clinically healthy dentine after caries removal with a rotary instrument (Fig. 5, right) or with Carisolv™ (Fig. 6, right) contained few bacteria; in Figure 6 (right) the number was below the detection limit of less than 10 per ml. A total of 95·2% of the samples, taken after treatment with Carisolv™, and 90·5% of the samples, taken after treatment with rotary instruments showed values that lay even below 10^2 CFU (Fig. 4). The reduction in total viable count was statistically significant (P = 0·0001) for both methods.

Colonies with different morphology types were also observed growing on MRS-agar plates. One of each type was analysed in the light microscope. All of them were rod-shaped microorganisms with cell morphologies which are characteristic of different species of lactobacilli. A total of 28·6% of the carious dentine samples contained less than 10^3 CFU per sample and 23·8% contained more than 10^5 CFU. Of all samples, 47·6% had values between 10^3 and 10^5 CFU (Fig. 7).

After treatment with Carisolv™ as well as with a rotary instrument, the level of lactobacilli in all clinically sound dentine samples reached at most

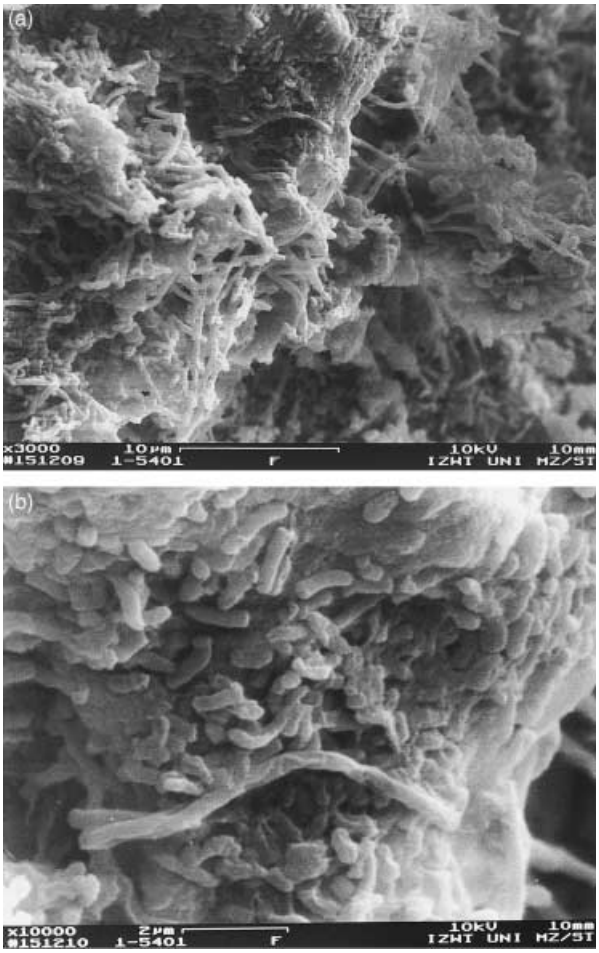

Fig. 3. (a) Scanning electron micrograph of carious dentine from a primary tooth showing mainly rod-shaped microorganisms of various lengths. Bar = 10 µm. (b) Detail from Fig. 3 (a) at a higher magnification, showing various rods and occasional coccal cells. Bar = 2 µm.

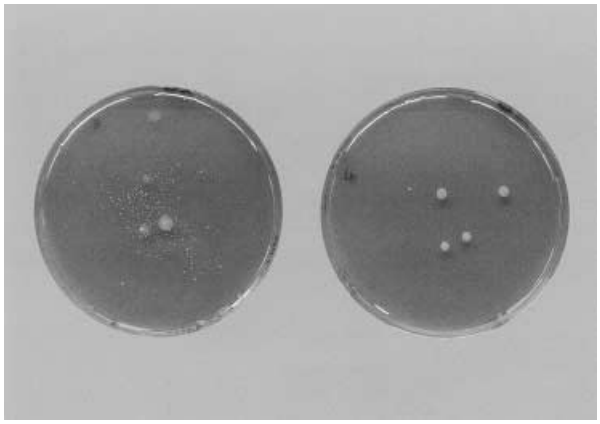

Fig. 5. Total viable counts on Schaedler agar plates from a carious dentine lesion (10^{-3}, left) and from sound dentine (10^{-1}, right) after caries removal with a rotary instrument.

10^3 CFU per sample, and 95·2% of the samples contained even less than 10^2 CFU. The reduction of the number of lactobacilli after caries removal by means of one of the two methods was of the same order of magnitude and was statistically significant (P = 0·0001) (Fig. 8).

Discussion

All primary teeth included in the present study showed brown, softened dentine, and were clinically classified as having deep-seated or moderate caries, according to the estimated depth of the cavity. Two teeth with a similar degree of destruction were chosen per patient for comparison of the two methods of

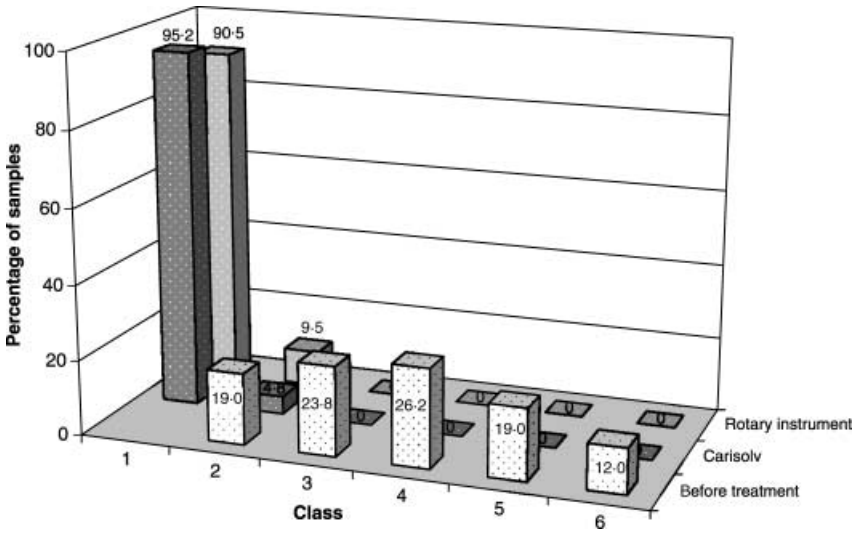

Fig. 4. Percentage of carious lesions before treatment or samples of residual dentine after caries removal by Carisolv™ or rotary instrument with total viable counts in class 1: ≤ 10^2, 2: 101–10^3, 3: 1001–10^4, 4: 10 001–10^5, 5: 100 001–10^6, 6: > 10^6.

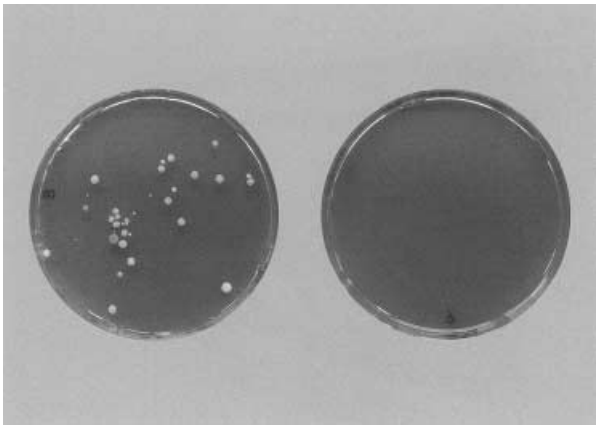

Fig. 6. Total viable counts on Schaedler agar plates from a carious dentine lesion (10^{-2}, left) and from sound dentine (10^{-1}, right) after caries removal with Carisolv™.

carious removal, since Kidd *et al*. [26,27] and Bjørndal *et al*. [28] had shown that the number of microorganisms present and the consistency of the carious dentine are linked. However, despite differences in the depths of the lesions no major differences in the number of bacteria colonizing the carious dentine samples were observed [28].

The number of microorganisms isolated from a site can also be influenced by the method of sample taking. Kidd *et al*. [26] used a standardized procedure for taking samples from residual dentine, by means of a round bur of a defined size, and established the reproducibility of this method. In this study, the dentine samples were carefully removed with a sterile excavator. This method was chosen to reduce the risk of accidental pulpal exposure, especially when sampling hard dentine.

While *Mutans streptococci* are mainly implicated with the initiation of enamel caries, they are only rarely the predominant species isolated from carious dentine. Instead, the composition of the microflora is known to become more complex as the lesions progress, and obligate anaerobes, mainly Gram-positive rods belonging to the genera *Propionibacterium*, *Eubacterium*, *Rothia*, *Lactobacillus*, *Bifidobacterium* and *Actinomyces*, become the predominant cultivable organisms in teeth without endodontic infections [29]. This was confirmed by the variety of different types of colony morphology observed in this study on Schaedler agar. In children, lactobacilli can be frequently isolated from dentinal lesions, and they have been found in 100% of all dentinal plaque samples in a group of children aged 5–15 years [30]. This study confirmed this finding in children aged 2–4 years; there was a high variation in the viable count of lactobacilli ($< 10^3$–$> 10^6$) but no correlation was found between the number of lactobacilli and the degree of destruction of the teeth. A separate determination of *Mutans streptococci*, the numbers of which were expected to be low, and are included in the total viable cell count, did not seem to provide any extra information and was therefore not considered further.

It was recently shown that by real-time PCR technique performed on human carious dentine, in addition to conventional culturing techniques, a higher

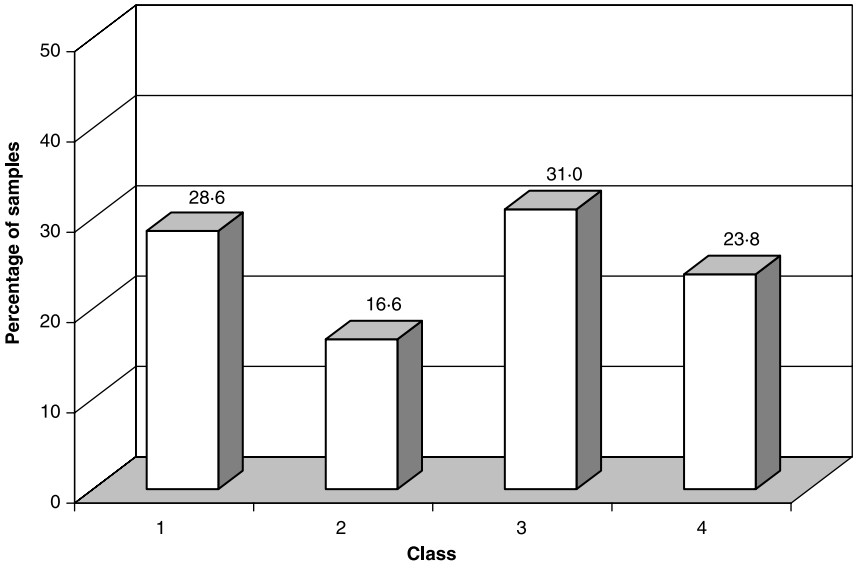

Fig. 7. Percentage of carious dentine samples with a viable count of lactobacilli in class 1: ≤ 10^3, 2: 1001–10^4, 3: 10 001–10^5, 4: > 10^5.

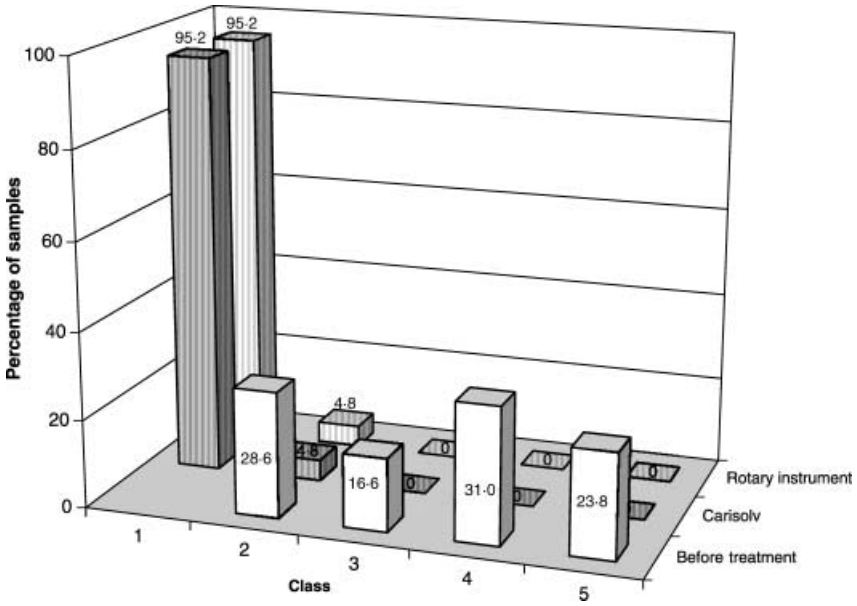

Fig. 8. Percentage of carious lesions before treatment or samples of residual dentine after caries removal by Carisolv™ or rotary instrument with viable counts of lactobacilli in class 1: ≤ 10^2, 2: 101–10^3, 3: 1001–10^4, 4: 10 001–10^5, 5: > 10^5.

number of anaerobes was detected [31]. The scanning electron micrographs of the carious dentine samples from this study revealed a variety of morphological types, some of which might have escaped detection by the culturing methods employed or might belong to organisms considered as unculturable. Thus the numbers for the viable bacteria might be actually slightly higher than those given in this study.

Dislodging the bacteria from carious dentine has to be achieved without disrupting the cells, and rod-shaped and filamentous bacteria are generally more susceptible to physical damage than coccal forms. It was shown, for example, that *S. mutans* was 600 times more resistant to sonic treatment than *Fusobacterium nucleatum* [32]. An established method for the dispersion of dental plaque samples is the use of glass beads, which some researchers also use for the processing of dentinal samples, while others only vortex for 20 s. The latter method, which was also used in this study, might yield an overall lower bacterial count, because some bacteria remain behind. However, this would be the case in the carious and in the sound dentine samples, and the reduction, expressed as a per cent, would not necessarily be affected.

It may be that small amounts of sodium hypochlorite may remain in the cavity after Carisolv™ treatment and removal of carious dentine. It is extremely unlikely, however, that bacteria still present in clinically sound dentine will be affected as they are protected from the gel. In addition, both ultrasonic irrigation and a higher concentration (5·5% or 12%) of sodium hypochlorite were necessary to achieve bacterial eradication from root dentine [33]. A recent study [34] also showed that Carisolv™ is effective in cleaning root canals, but only in combination with ultrasonic treatment.

Nowadays, a cavity is judged to be clinically caries-free according to tactile, acoustic and optical criteria. Several investigations could show that often a low number of residual microorganisms (10^1–10^3 CFU) remains behind in clinically sound hard dentine in spite of a significant reduction in the bacterial count; however, this low number of bacteria is considered to be clinically acceptable by several authors [26–28]. Both Heinrich *et al.* [35] and Kidd *et al.* [27] studied the relationship of the clinical appearance of carious dentine and the number of bacteria, and they found, as in this study, values below 10^2 CFU for the total bacterial count for streptococci and lactobacilli in hard dentine.

When using Carisolv™, the clouding of the applied gel is given as a caries indicator by the manufacturer. The cavity is judged to be caries-free when the gel no longer turns cloudy with debris. In this study, comparison of the two methods from a bacteriological point of view showed that the total viable count was reduced to less than 10^2 CFU in 90·5% of the samples after treatment with rotary instruments and in 95·2% of the samples after the application of Carisolv™. The viable count of the

lactobacilli was also reduced to less than 10^2 CFU in 95·2% of the samples after treatment using one or the other method. The numbers of bacteria that Kneist *et al*. [20] found in their samples after treatment with Carisolv™ were of the same order of magnitude.

When comparing cavities clinically after caries removal with Carisolv™ or by means of conventional method, recurrent caries was found in only a small number of cases; Zimmermann *et al*. [18] found no secondary caries after one year in 13 teeth after conventional caries removal while it had developed in four out of 82 teeth treated with Carisolv™. The authors themselves point out the different sizes of the groups. In another study on two groups of equal size, secondary caries was observed after one year in 8% of the cases treated with Carisolv™ and in 5% of the conventionally excavated teeth [36]. After the same period of time, Fure *et al*. [16] found that 34 patients with dentinal root caries remained completely caries-free after treatment with Carisolv™. In order to judge these results one needs to keep in mind that residual bacteria cannot be held solely responsible for occurence of caries, since individual factors like oral hygiene and dietary habits of the patients, may also greatly influence caries progression.

Conclusions

Carious dentine sampled from children with early childhood caries contained high numbers of coccal and rod-shaped bacteria; filamental forms were seen occasionally. Both methods of caries removal produced a statistically significant reduction in the total viable count and in the viable count of lactobacilli. In the samples from clinically healthy dentine, taken after caries removal, lactobacilli and other bacteria were present in low numbers. The results from this microbiological study indicate that the efficacy of chemomechanical removal of carious dentine in children by means of Carisolv™ is comparable to the results obtained by conventional methods, and might serve as a suitable alternative. However, further investigations, including longitudinal studies are necessary to determine the effect of Carisolv™ on sound dentine and on the pulp.

Résumé. *Objectifs.* L'usage de procédures invasives minimales et l'attention portée au confort du patient sont extrêmement importants, notamment lors de soins dentaires chez le jeune enfant. Ceci a amené au développement de méthodes de traitement mécano-chimique des caries. Cette étude a eu pour objectif de comparer l'efficacité de l'élimination mécano-chimique des caries et celle de l'excavation conventionnelle dans la réduction du compte de la flore cariogénique.

Protocole et mise en place. Les sujets ont été choisis parmi les enfants admis dans la clinique dentaire pour soins dentaires sous anesthésie générale.

Echantillons et méthodes. Vingt-et-un enfants (âge moyen 43,5 ± 12,0 mois) avec caries précoces ont été inclus dans cette étude. Deux dents lactéales avec des degrés comparables de destruction carieuse ont été choisies chez chaque enfant ($n = 42$) pour élimination de la carie avec Carisolv™ ou à l'aide d'instruments rotatifs. Des échantillons de dentine cariée ont été récupérés à l'aide d'un excavateur stérile, puis toute la dentine ramollie a été éliminée et un second échantillon prélevé. Tous les échantillons ($n = 84$) ont été dilués de façon sérielle et ensemencés sur deux géloses nutritives différentes (Schaedler, MRS).

Résultats. Après 24 h d'incubation le compte total bactérien et compte de lactobacilles ont été évalués. 12% des échantillons de dentine carieuse contenaient plus de 10^6 bactéries, 23,8% contenaient plus de 10^5 lactobacilles. Les deux méthodes d'élimination de la carie ont induit une réduction statistiquement significative des comptes bactériens ($p = 0{,}0001$). Dans au moins 90,5% des échantillons récupérés après l'élimination, le compte total bactérien était inférieur à 10^2, et dans 95,2% les lactobacilles étaient sous 10^2.

Conclusion. Ces résultats indiquent que l'efficacité, chez l'enfant, de l'élimination mécano-chimique à l'aide du Carisolv™ est comparable aux obtenus par des méthodes conventionnelles, et pourrait donc constituer une alternative adaptée.

Zusammenfassung. *Ziele.* Die Verwendung minimal invasiver Verfahren und die Berücksichtigung des Patientsnbefindens sind von hoher Wichtigkeit, insbesondere bei kleinen Kindern. Daher wurde eine chemomechanische Methode der Kariesentfernung entwickelt. Ziel dieser Studie war es, die Wirksamkeit dieser chemomechanischen Kariesentfernung mit konventionellem Exkavieren anhand der Reduktion der Bakterienzahlen kariespathogener Keime zu vergleichen.

Stichprobe und Methoden. Es wurden Kinder einbezogen, die zzur konservierenden Behandlung

Narkose überwiesen worden waren.21 Kinder (mittleres Alter 43.5 ± 12.0 Monate) mit frühkindlicher Karies wurden in dieser Studie einbezogen. Zwei Milchzähne mit vergleichbaren kariösen Läsionen wurden in die Studie aufgenommen. Proben des kariösen Dentins wurden mit einem sterilen Handinstrument entnommen, danach wurde die Karies entfernt und jeweils eine weitere Proben gewonnen. Alle Proben wurden in einer Verdünnungsreihe aufbereitet und auf zwei unterschiedlichen Nährböden (Schaedler, MRS) bebrütet.
Ergebnisse. Nach 24 h Inkubation wurde die Zahl der koloniebildenden Einheiten ermittelt. 12% der Proben enthielten mehr als 10^6 Bakterien, 23.8% enthielten mehr als 10^5 Laktobazillen. Beide Methoden der Kariesentfernung Bei mindestens 90.5% der Proben lag die Zahl der Bakterien nach Kariesentfernung unter 10^2, bei 95.2% war die Zahl der Laktobazillen unter 10^2.
Schlussfolgerung. Die Ergebnisse zeigen eine vergleichbare Wirksamkeit der chemomechanischen Kariesentfernung mit den Ergebnissen der konventionellen Methoden, daher könnte sie eine Therapiealternative darstellen.

Resumen. *Objetivos.* El uso de procedimientos mínimamente invasivos y la atención al confort del paciente son de gran importancia, especialmente en el tratamiento dental de niños pequeños. Esto ha conducido al desarrollo de métodos químico-mecánicos para la eliminación de la caries. El objetivo de este estudio fue comparar la eficacia de la eliminación químico-mecánica de la caries con el de la excavación convencional en la reducción de la flora cariogénica.
Diseño y población. Los sujetos para este estudio se escogieron niños, admitidos a la clínica dental para procedimientos restauradores bajo anestesia general.
Muestra y método. Se incluyeron en este estudio 21 niños (edad media 43,5 ± 12,0 meses) con caries del niño pequeño. En cada niño ($n = 42$) se escogieron dos dientes deciduos con grados comparables de destrucción por caries, para la eliminación de caries con Carisolv™ o por medio de instrumentos rotatorios. Las muestras de la dentina cariada se tomaron con un instrumento de raspado estéril, después de eliminar toda la dentina blanda, se tomaba una segunda muestra. Todas las muestras ($n = 84$) se diluyeron en serie y se colocaron en una platina con dos nutrientes de agar diferentes (Schaedler, MRS).
Resultados. Después de 24 h de incubación se determinaron las unidades formadoras de colonias para recuento bacteriano total y de lactobacilos. El 12% de las muestras de dentina cariada contenían más de 10^6 bacterias, el 23,8% contenían más de 10^5 lactobacilos. Ambos métodos de eliminación de caries produjeron una reducción estadísticamente significativa en el recuento bacteriano ($p = 0{,}0001$). Al menos en el 90,5% de las muestras tomadas después de la eliminación, el recuento bacteriano total estuvo por debajo de 10^2, y en el 95,2% de lactobacilos estaban por debajo de 10^2.
Conclusión. Estos resultados indican que la eficacia de la eliminación químico-mecánica de dentina cariada en niños mediante Carisolv™ es comparable a los resultados obtenidos por métodos convencionales y por tanto podría servir como alternativa deseable.

References

1 Willershausen B, Azrak B, Wilms S. Fear of dental treatment and its possible effects on oral health. *European Journal of Medical Research* 1999; **4**: 72–77.
2 Banerjee A, Watson TF, Kidd EAM. Dentine caries excavation: a review of current clinical techniques. *British Dental Journal* 2000; **188**: 476–482.
3 Ericson D, Zimmerman M, Raber H, Götrick B, Bornstein R, Thorell J. Clinical evaluation of efficacy and safety of a new method for chemo-mechanical removal of caries. A multi-centre study. *Caries Research* 1999; **33**: 171–177.
4 Burke FJT, Crisp RJ, Hall AF. Patient's perceptions after treatment with Carisolv™ in general dental practice. *Journal of Dental Research* 1999; **78**: 1041.
5 Masouras C, Staikou O, Kakaboura A, Vougiouklakis G. A comparative clinical study of Carisolv™ caries removal method. *Journal of Dental Research* 2001; **80**: 1201.
6 Haffner C, Benz C, Folwaczny M, Hickel R. Chemomechanical caries removal – a clinical study. *Caries Research* 1999; **33**: 312.
7 Beeley JA, Yip HK, Stevenson AG. Chemomechanical caries removal: a review of techniques and latest developments. *British Dental Journal* 2000; **188**: 427–430.
8 Zinck JH, McInnes-Ledoux P, Capdeboscq C, Weinberg R. Chemomechanical caries removal – a clinical evaluation. *Journal of Oral Rehabilitation* 1988; **15**: 23–33.
9 Habib CM, Kronman J, Goldman M. A chemical evaluation of collagen and hydroxyproline after treatment with GK-101 (N-chloroglycine). *Pharmacology and Therapeutics in Dentistry* 1975; **2**: 209–215.
10 Kronman JH, Goldman M, Habib CM, Mengel L. Electron microscopic evaluation of altered collagen structure induced by N-chloroglycine (GK101). *Journal of Dental Research* 1977; **56**: 1539–1545.
11 Hand RE, Smith ML, Harrison JW. Analysis of the effect of dilution on the necrotic tissue dissolution property of sodium hypochlorite. *Journal of Endodontics* 1978; **4**: 60–64.
12 Schutzbank SG, Galaini J, Kronman JH, Goldman M, Clarke REA. A comparative in vitro study of the effect of GK-101 and GK-101E in caries removal. *Journal of Dental Research* 1978; **57**: 861–864.

13 Roth KK-F, Domnick E, Ahrens G. Untersuchungen über die Effektivität von Caridex® bei der Kariesentfernung. *Deutsche Zahnärztliche Zeitschrift* 1989; **44**: 463–465.
14 Yip HK, Stevenson AG, Beeley JA. An improved reagent for chemomechanical caries removal in permanent and deciduous teeth: an in vitro study. *Journal of Dentistry* 1995; **23**: 197–204.
15 Hannig M. Effect of Carisolv™ solution on sound, demineralized and denatured dentin – an ultrastructural investigation. *Clinical Oral Investigations* 1999; **3**: 155–159.
16 Fure S, Lingström P, Birkhed D. Chemo-mechanical removal of root caries compared to drilling. *Journal of Dental Research* 1999; **78**: 108.
17 Ericson D. In vitro efficacy of a new gel for chemo-mechanical caries removal. *Journal of Dental Research* 1998; **77**: 1252.
18 Zimmerman M, Raber H, Götrick B, Ericson D, Bornstein R, Kultje C. Clinical evaluation of a chemo-mechanical caries removal method – one-year follow-up. *Journal of Dental Research* 2000; **79**: 1296.
19 Dammaschke T, Dähne L, Kaup M, Stratmann U, Ott K. Effektivität von Carisolv im Vergleich zu konventionellen Methoden zur Entfernung kariösen Dentins. *Deutsche Zahnärztliche Zeitschrift* 2001; **56**: 472–475.
20 Kneist S, Heinrich-Weltzien R, Stösser L. Zur Mikroflora am Kavitätenboden von Milchmolaren nach chemomechanischer Kariesexkavation mit Carisolv. *Quintessenz* 2002; **53**: 461–469.
21 Dammaschke T, Stratmann U, Kaup M, Ott K. *Histologische Veränderungen an intaktem und demineralisiertem Dentin durch Carisolv®*. Abstract 13th Annual Congress of DGZ. Saarbrücken: 1999: 79.
22 Galler G, Duschner H, Götz H. Migration of Carisolv® into sound dentin in vitro: 3D histotomographic studies by confocal laser scanning microscopy (CLSM). *Caries Research* 2000; **34**: 338.
23 Young C, Bongenhielm U. A randomized, controlled and blinded histological evaluation of Carisolv™ on pulpal tissue. *Journal of Dental Research* 2000; **79**: 1297.
24 Marsh P, Martin M. *Oral Microbiology*, 3rd edn. 1992. London, Glasgow, New York, Tokyo, Melbourne, Madras: Chapman & Hall: 133–165.
25 Hahn C-L, Falkler WA, Minah GE. Microbiological studies of carious dentine from human teeth with irreversible pulpitis. *Archives of Oral Biology* 1991; **36**: 147–153.
26 Kidd EAM, Joyston-Bechal S, Beighton D. Microbiological validation of assessments of caries activity during cavity preparation. *Caries Research* 1993; **27**: 402–408.
27 Kidd EAM, Ricketts DNJ, Beighton D. Criteria for caries removal at the enamel-dentine junction: a clinical and microbiological study. *British Dental Journal* 1996; **180**: 287–291.
28 Bjørndal L, Larsen T, Thylstrup A. A clinical and microbiological study of deep carious lesions during stepwise excavation using long treatment intervals. *Caries Research* 1997; **31**: 411–417.
29 Hoshino E. Predominant obligate anaerobes in human carious dentin. *Journal of Dental Research* 1985; **64**: 1195–1198.
30 Nancy J, Dorignac G. Lactobacilli from the dentin and saliva in children. *Journal of Clinical Pediatric Dentistry* 1992; **16**: 107–111.
31 Martin FE, Nadkarni MA, Jacques NA, Hunter N. Quantitative microbiological study of human carious dentine by culture and real–time PCR. Association of anaerobes with histopathological changes in chronic pulpitis. *Journal of Clinical Microbiology* 2002; **40**: 1698–1704.
32 Robrish SA, Grove SB, Bernstein RS, Marucha PT, Socransky SS, Amdur B. Effect of sonic treatment on pure cultures and aggregates of bacteria. *Journal of Clinical Microbiology* 1976; **3**: 474–479.
33 Huque J, Kota K, Yamaga M, Iwaku M, Hoshino E. Bacterial eradication from root dentine by ultrasonic irrigation with sodium hypochlorite. *International Endodontic Journal* 1998; **31**: 242–250.
34 Al-Kilan MG, Whitworth JM, Dummer TMH. Preliminary *in vitro* evaluation of Carisolv™ as a root canal irrigant. *International Endodontic Journal* 2003; **36**: 433–440.
35 Heinrich R, Kneist S, Künzel W. Klinisch kontrollierte Untersuchung zur Caries-profunda-Therapie am Milchmolaren. *Deutsche Zahnärztliche Zeitschrift* 1991; **46**: 581–584.
36 Nevrin K, Karlén M. One-year follow-up comparing chemomechanical caries excavation with drilling. *Journal of Dental Research* 2000; **79**: 1296.