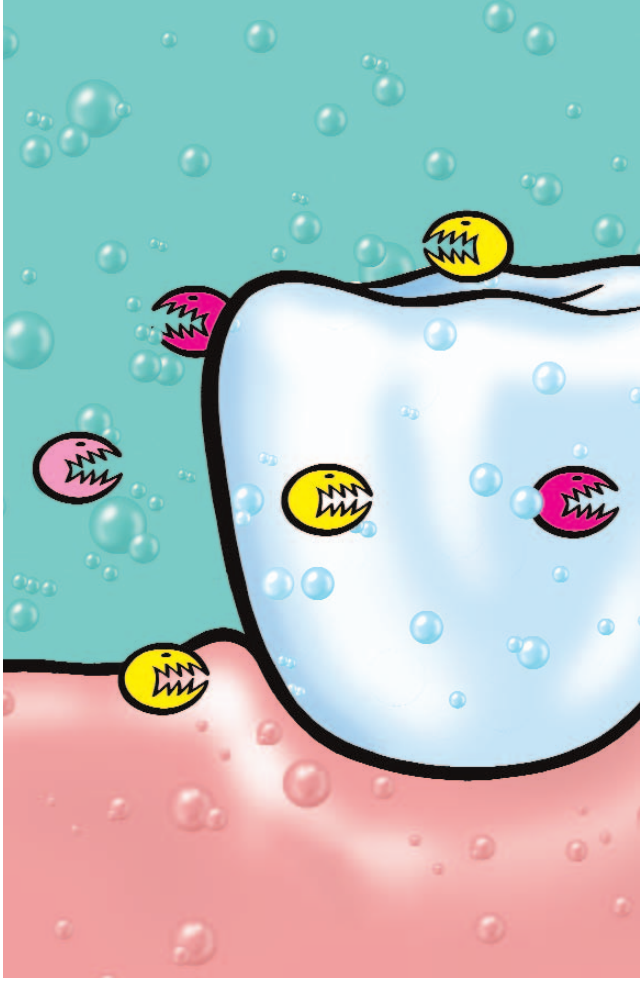

Focus on

CRT® bacteria

Caries Risk Test

ivoclar vivadent clinical

Table of contents page

1. Microorganisms – A key to caries

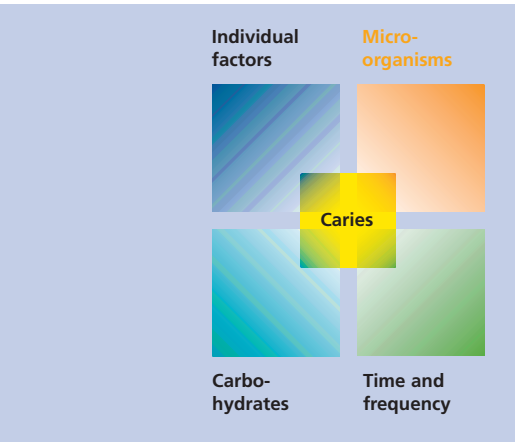

Figure 1: Factors influencing the development of carious defects (according to König, 1971)

Various factors influence dental health. Important is the interaction between harmful and protective factors. Microorganisms, sugar, and unhealthy eating habits are detrimental to dental health, whereas saliva, oral hygiene, and the natural resistance of the teeth represent the protective counterweight (Fig. 1). Microorganisms play a key role in the development and progression of caries. Usually, the various types of bacteria in the oral cavity are in equilibrium. The risk of developing disease increases if the number of certain bacteria, i.e. mutans streptococci or lactobacilli, substantially rises, while the protective factors cease to function optimally. Special properties render these bacteria highly cariogenic.

2. Mutans streptococci

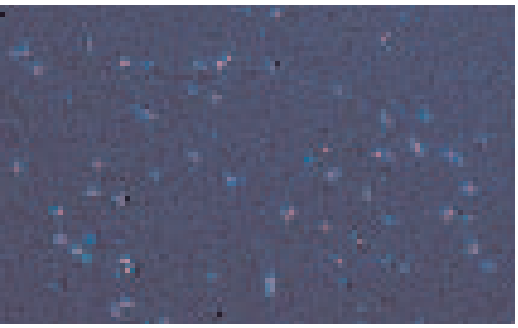

Figure 2: Mutans streptococci
Picture by PD Dr. S. Kneist, Erfurt, Germany

High sugar intake combined with frequently low pH-values leads to an increase in the number of mutans streptococci, i.e. S. mutans and S. sobrinus, in the oral cavity (Fig. 2). These germs are grampositive coccoidal bacteria, characterized by the following properties:

- ➔ Capacity to adhere to the tooth structure
- ➔ Sugar transport system
- ➔ Production of lactic acid from sugar
- ➔ Production of intra- and extracellular polysaccharides
- ➔ Tolerance of an acid environment

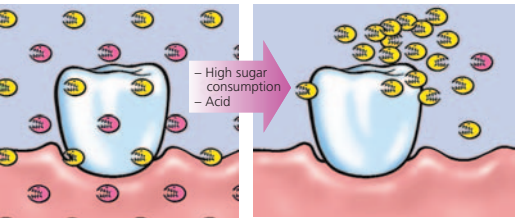

Figure 3: Change in the ecological balance

Mutans streptococci transport sugar

Mutans streptococci are equipped with a very efficient transport system that transports sugar into their cells (Hamada and Slade 1980). During the metabolic processes within the cells, they produce various substances, which contribute considerably to their pathogenicity. When high levels of sugar are consumed, the mutans streptococci produce mainly lactic acid. This break-down proceeds much more rapidly compared with other bacteria (Hamada and Slade 1980; Loesche 1986). The metabolism takes place in both neutral and acid environments, with continuing activity at low pH-values (Köhler et al. 1995).

Mutans streptococci produce intra- and extracellular polysaccharides

Extracellular polysaccharides are also produced during the course of enzymatic reactions. Their stickiness favours the adherence of bacteria on tooth surfaces, which enables them to settle on even very smooth surfaces (Koga et al. 1986; Loesche 1986). Given their numerous reception sites for microorganisms, polysaccharides also promote the crosslinkage and multiplication of plaque. Moreover, their insolubility in water hampers the natural protective effect of saliva (Hamada and Slade 1980). Intracellular polysaccharides ensure bacterial survival during low-nutrition intervals, and are used by the bacteria to produce further acids (Hamada and Slade 1980).

Mutans streptococci tolerate an acid environment

Bacteria that quickly multiply under certain ecological conditions have a clear advantage over other germs. Nutrition and the absence of suppressing factors determine the composition of the oral flora. Falling pH-levels prevent many bacteria from growing, whereas the mutans streptococci counts increase (Harper and Loesche 1984). By producing additional acids, they maintain this environment, which further promotes multiplication (Marsh 1994). The bacterial flora changes to comprise bacteria capable of surviving in an acid environment at the expense of less acid-tolerant and less acid-producing microorganisms (Fig. 3). Plaque takes on a cariogenic property (Marsh and Bradshaw 1997). The pathogenic germs produce acids, the pH-value of which is lower than the threshold value below which dental enamel starts to dissolve (Burne 1997). Mutans streptococci are regarded as being the initiators of caries. They trigger the process that leads to initial mineral loss and that enables bacteria to penetrate the tooth structure.

Transmission of mutans streptococci

The oral cavity of newborn children does not contain any mutans streptococci (Carlsson et al. 1970). They appear only after the eruption of the teeth, as they can settle on hard surfaces (Hamada and Slade 1980). Mutans streptococci are transmitted via saliva, most frequently the mother's (Li and Caufield 1995; Caufield and Walker 1995). Mothers are most often the main source of infection due to the close (Fig. 4) and frequent contact between mother and child during the first few years (Alaluusua 1991). The transmission vehicle may be, for example, a contaminated pacifier (dummy) or spoon, which the mother quickly licked clean (Fig. 5) before giving it to her child (Alaluusua 1991). A few years ago, it was believed that on average mutans streptococci started to appear in a child's oral cavity at the 26th month of life ('window of infectivity',

Figure 4: Mother and child in close contact

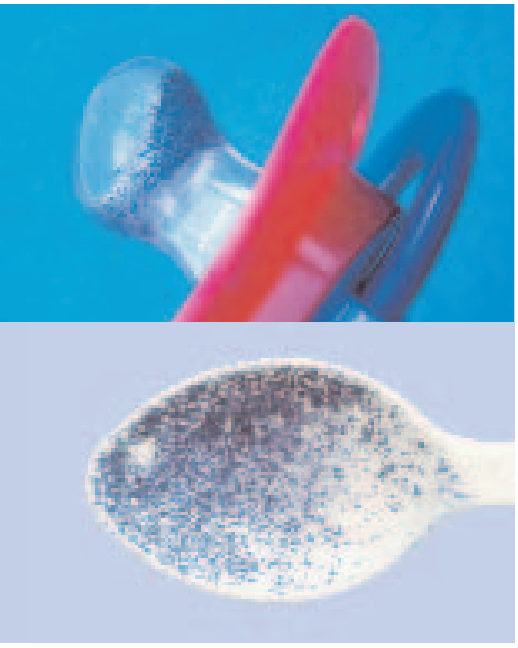

Figure 5: Pacifier and spoon contaminated with mutans streptococci
Picture by PD Dr. S. Kneist, Erfurt, Germany

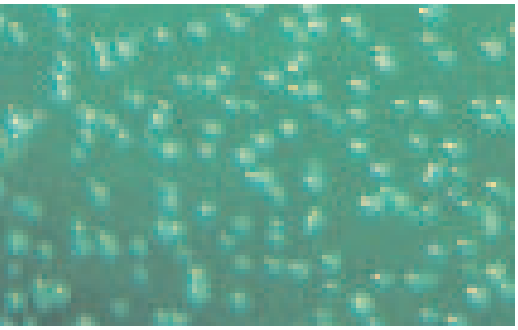

Figure 6: Lactobacilli
Picture by PD Dr. S. Kneist, Erfurt, Germany

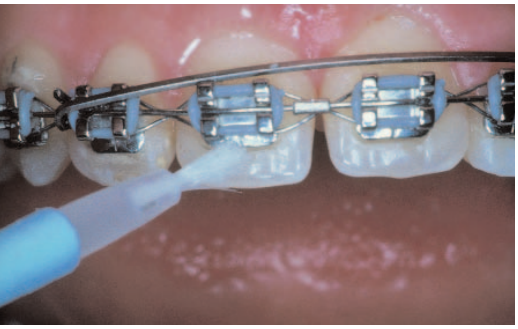

Figure 7: Ideal retention niches for lactobacilli

Caufield et al. 1993). More recent research, however, suggests that high levels of salivary mutans streptococci may occur in some children before they have reached their first birthday (Plotzitza et al. 2002). Mutans streptococci were also found in the plaque of 12-month old children (Habibian 2002).
In this context, the bacterial count of the mother plays an important role. If she exhibits low mutans streptococci levels, the child's count usually also remains low. Children of mothers with high bacterial levels, however, tend to develop high counts themselves (Köhler et al. 1983; Caufield et al. 1993). The transmission of bacteria is especially destructive during tooth eruption, since mutans streptococci find it particularly easy to colonize on the still porous enamel. Performing oral hygiene is also very difficult at this stage, thus bacterial counts should be kept as low as possible in mothers to minimize the risk of transmission (Köhler et al. 1984; Tenuvuo et al. 1992; Günay et al. 1996). There seems to be a correlation between the time mutans streptococci appeared in the oral cavity and the extent of subsequent caries (Grindefjord et al. 1991; Alaluusua and Malmivirta 1994). This fact underlines the importance of early identification of mutans streptococci in order to develop the corresponding strategies to suppress their occurrence and thus prevent caries.

3. Lactobacilli

Lactobacilli (Fig. 6) are mainly responsible for caries progression (Featherstone, 2000), i.e. they cause active damage to the tooth structure by multiplying and spreading the bacteria. They are characterized by the following properties:

- Colonization in retention niches
- Acid production
- Acid tolerance
- Indicators of high sugar intake

Lactobacilli prefer retention niches

Up to the second year of a child's life, lactobacilli come mostly from the mother (Carlsson et al. 1975). Usually, there are only few lactobacilli in saliva. Their number increases if mutans streptococci start to colonize in the oral cavity, since they produce a favourable acid environment for lactobacilli, so the pH-value decreases (Newbrun 1992). Lactobacilli preferably settle in niches with a low pH-value and in the vicinity of plaque accumulation (Beighton and Brailsford 1998). Consequently, lactobacilli can also be found in cavities and carious dentin. In contrast to mutans streptococci, lactobacilli do not adhere to tooth surfaces on their own account, but need natural or iatrogenic retention niches (Fig. 7), such as:

- pits and fissures
- cavities
- marginal gaps of restorations
- brackets

These areas are usually difficult to reach and clean. Carious dentin and areas at of the margins of lesions demonstrate higher lactobacilli counts than in surface plaque. This can be explained by the difference in environment, i.e. supragingival plaque is in direct contact with saliva and its components.

Lactobacilli produce and tolerate acids

The cariogenic potential of lactobacilli can be attributed to several properties. The bacteria produce acids from sugar, particularly lactic acid. Lactobacilli preferably settle and multiply in an acid environment, even at a very low pH-value of 5.2. They are more resistant to bacteria-reducing substances, such as chlorhexidine, than mutans streptococci and are usually found in areas that are difficult to clean. Fluoride also does not show the same effect on the bacterial metabolism as it does on mutans streptococci (Beighton and Brailsford 1998). Lactobacilli are fluoride resistant. Therefore, it is not surprising that there is a significant correlation between carious lesions and the lactobacilli count in both adults and children (Hardie et al. 1977). Children with cavities that need to be restored demonstrate clearly higher lactobacilli counts than children with restored cavities (Kneist et al. 1998). Furthermore, a high lactobacilli count is an indicator of high sugar intake (Beighton and Brailsford 1998).

4. Correlation between the bacterial count in plaque and saliva

Basically, the oral microflora of infants differs from that of older children, adolescents, or adults. Their bacterial counts are generally much lower and, frequently undetectable (Alaluusua et al. 1989). There is a connection between the isolation frequency of mutans streptococci and the age, the number of teeth, and the number of retention sites (Catalanotto et al. 1975; Alaluusua and Renkonen 1983). The more areas of dentition that are affected by mutans streptococci, the higher is the bacterial count in the saliva of small children (Alaluusua et al. 1989). There is a correlation between the occurrence of mutans streptococci in plaque and that in saliva (Mundorff et al. 1990; Sullivan et al. 1996; Kneist 1998; Kneist et al. 1998; Kneist et al. 1999). If saliva contains high bacterial counts, plaque does too. High counts in saliva correlates to > 10^3 CFU mutans streptococci in plaque (Kneist 1998).

5. Microbiological findings enable early intervention

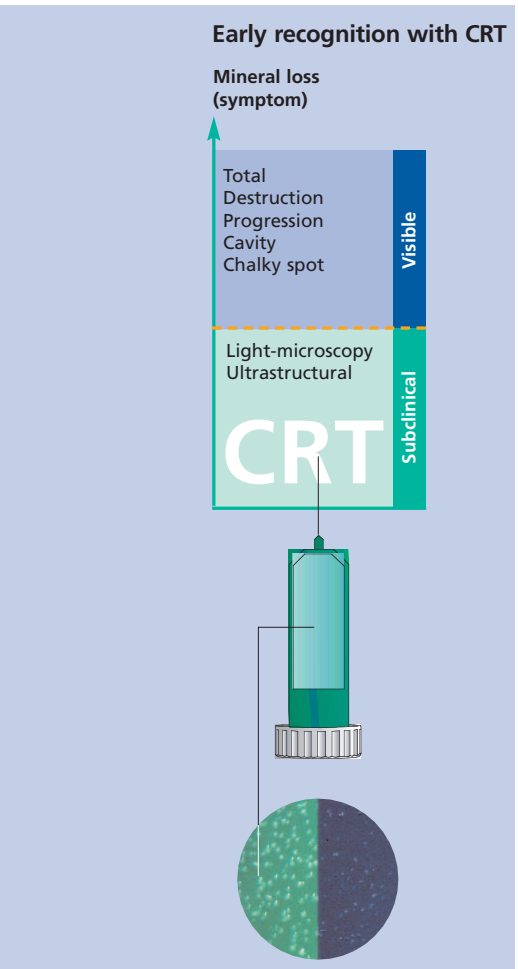

Figure 8: Microbiological methods permit a glance at subclinical spheres

Cavities are rather belated occurrences. Clinical inspection enables the detection of chalky white spots before cavities arise. However, this stage is preceded by demineralized areas, invisible to the eye which can only be detected by highly sophisticated methods. In such cases, the evaluation of microbiological findings enables early intervention, even before defects become visible (Loesche 1986) (Fig. 8).

6. Mutans streptococci and lactobacilli

A clear dominance of mutans streptococci alone is not decisive for a high caries risk. Lactobacilli alone or the combination of mutans streptococci and lactobacilli also come into play. Consequently, the occurrence of both types of bacteria must be evaluated (Loesche 1986).

If lactobacilli are present in an environment where the protective factors are missing, there is a high risk that caries will develop (Leverett et al. 1993). In general, the determination of both the mutans streptococci and the lactobacilli counts increases the accuracy of the diagnosis and thus improves the subsequent prognosis (Alaluusua et al. 1989; Kneist et al. 1997; Stecksen-Blicks 1985). Determining the mutans streptococci and lactobacilli counts in elderly patients deserves particular attention with regard to the development of root caries, although other microorganisms also play a role here (Ellen et al. 1985; Fure and Zickert 1990; Ravald et al. 1993, Shen et al. 2002).

Detection of mutans streptococci

In the field of microbiological culture methods, mutans streptococci are identified by means of standard test procedures involving mitis-salivarius agar, which contains bacitracin (Gold et al. 1973). Several substances ensure the high selectivity of this procedure, such as sucrose and bacitracin, a polypeptide antibiotic, as well as various salts, with the latter being responsible for the blue colouring of the agar. Mutans streptococci demonstrate a high resistance to this combination whereas other microorganisms are inhibited. If undiluted plaque and saliva samples are used or samples taken from softened dentin and smears from the dorsum of the tongue, enterococci and yeasts may also be cultured. However, these colonies can be clearly distinguished from those of mutans streptococci by their appearance. Enterococci appear in flat, dark-blue-brown colonies, while yeasts form large white to mat light-blue colonies (Fig. 9). These bacteria do not cause any problems in the routine use of the MSB-agar (Gold et al. 1973).

Detection of lactobacilli

At the beginning of the fifties, the Rogosa agar made its way into the microbiological laboratories for the detection of lactobacilli (Rogosa et al. 1951). The tomato juice agar used until that time had proven to be very sensitive to a considerable number of intervening germs, which substantially complicated the identification of lactobacilli. In contrast to this agar, Rogosa agar permits the selective detection of lactobacilli and has remained the laboratory standard to this day. Yeasts may occur, but only rarely and in very low numbers (Fig. 10). Their appearance is also clearly distinguishable from that of lactobacilli (Rogosa et al. 1951). The corresponding colonies are relatively large and cream-coloured. In case of doubt, they can be identified by adding drops of H_2O_2*. Yeasts start 'bubbling' (Fig. 11). Candida albicans is one of the most frequently occurring yeasts; a mucosal parasite that is present in the oral flora of almost half of the adult population (Arendorf and Walker 1980; Lehner 1967). While low levels of Candida albicans do not cause painful symptoms, an elevated density of colonization causes the unpleasant concomitants of candidiasis, such as an itchy or burning reaction of the mucosal areas affected (Epstein et al. 1980). Furthermore, the aggregation of C. albicans and S. mutans may result in pathogenic synergetic effects (Linossier 2002). Yeasts of the genus Candida have been associated with the formation of caries for several years (Moalic et al. 2001),

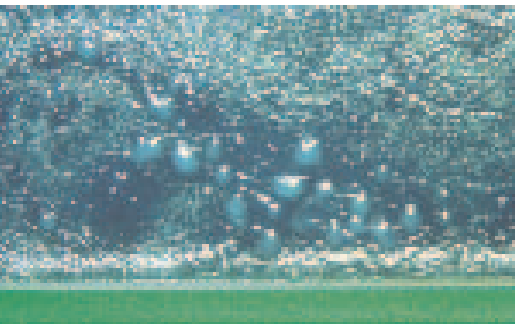

Figure 9: Yeast on the MS side

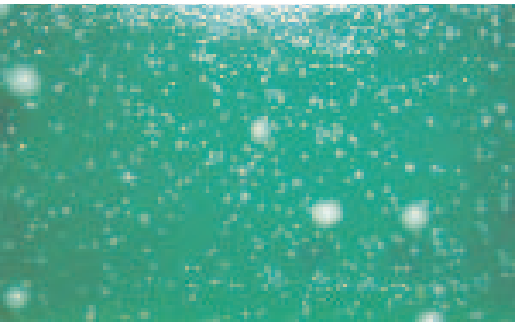

Figure 10: Yeast on the LB side

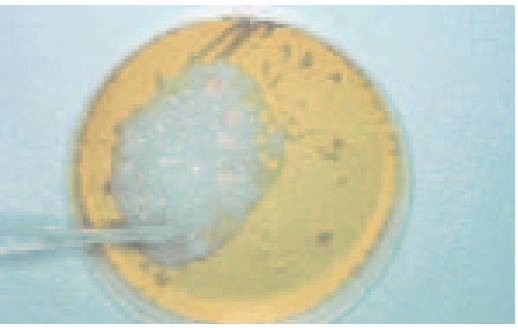

Figure 11: Identifying yeast by means of H_2O_2

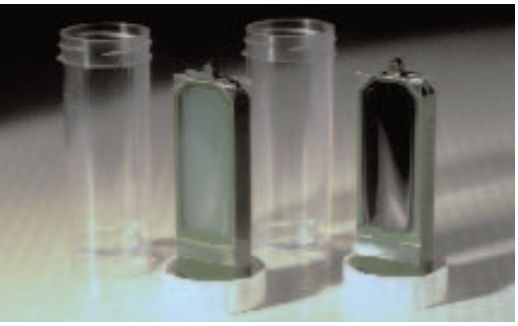

Figure 12: CRT bacteria - the blue agar is used to determine the mutans streptococci counts, while the light agar is used to identify lactobacilli

and in-vitro tests they have triggered caries in the absence of lactobacilli and mutans streptococci (Wetzel et al. 1997). Various diseases, reduced saliva flow rate and a reduced buffer capacity of the saliva promote their spread (Meurman and Rantonen 1994; Nähri et al. 1993; Odds 1988). Consequently, the appearance of yeasts provides important additional information.

*Remark: H_2O_2 = Hydrogen peroxide

Requirements placed on caries risk tests

Microbiological laboratory investigations require trained personnel and laboratory equipment, which is far beyond the means of a dental practice. Simplified procedures suitable for dental practices must meet requirements regarding validity, reliability, and ease of handling. The media used should be able to detect mutans streptococci and lactobacilli almost exclusively. Further-more, a prognostic value in regard to the probability of developing the disease should be available. A patient shown to demonstrate a high caries risk (positive), should therefore develop severe caries after a number of years whereas a patient classified as low-caries-risk (negative) should exhibit only a slight caries increase, if at all. In other words, false-positive or false-negative test results should be minimized. For a multi-causal disease, such as caries, however, it has to be pointed out that there is no test available which is suitable to record the resistance or predisposition of the host, the microorganisms, and nutrition habits simultaneously (Newbrun et al. 1983).

Introduction of chair-side tests in dental practices

Chair-side tests for dental practices have been available since the beginning of the seventies. These tests permit the semi-quantitative determination of mutans streptococci and lactobacilli in saliva (Larmas 1975; Jordan et al. 1987; Jensen and Bratthall 1989). The range of established test systems include Dentocult® SM and Dentocult® LB from Orion Diagnostica, Cariescreen® SM from APO Diagnostics, as well as CariesCheck® SM and CariesCheck® LB from Hain Diagnostika. They all have one thing in common: they are all based on culture methods. Saliva stimulated by chewing a paraffin pellet is brought into contact with the culture medium. After incubation at 37° C / 99° F in an incubator, the test samples are evaluated by determining the bacteria counts and comparing them with the corresponding charts. Various attempts have been made to optimize the tests in accordance with findings from practical experience. Complicated working procedures involve various sources of error. Different incubation times of the respective mutans streptococci or lactobacilli tests, the expenditure of materials due to various test vials, the short shelf life of the MS tests in particular, and the unreliable selectivity of certain products are only a few of the drawbacks. Recently, a trend towards using quick tests that provide the results in the course of a single appointment has emerged. These tests are based on various methods. For instance, monoclonal antibodies are employed in Saliva-Check from GC, while Clinpro™ Cario L-Pop™ from 3Mespe uses local measurement of acid production as a means of assessment. The methods on which these tests are based are not yet fully matured in terms of their sensitivity and handling properties.

7. CRT bacteria – a step forward

The CRT bacteria caries risk test from Ivoclar Vivadent represents progress for the dental practice. It enables the simultaneous determination of the mutans streptococci and lactobacilli counts in saliva by means of selective agars. The blue mitis-salivarius-agar with bacitracin is used to detect mutans streptococci, while the light culture medium, Rogosa agar, is used to evaluate lactobacilli (Fig. 12). Foils protect the agars from drying out and contamination. The deep indentation in the carriers prevents the culture media from slipping out.

CRT bacteria correlates with standard methods

The comparison of CRT bacteria with laboratory methods shows a convincing correlation (Brailsford et al. 1998; Kneist et al. 1998). The same is valid for the comparison with the Dentocult system from Orion Diagnostica, which used to be the standard chair-side procedure until the late nineties (Kneist et al. 1999; Steinberg 1998). The assessment of the caries risk on the basis of the mutans streptococci and lactobacilli findings of both test systems shows excellent correspondence. 54% of the children examined demonstrated an equally low caries risk according to

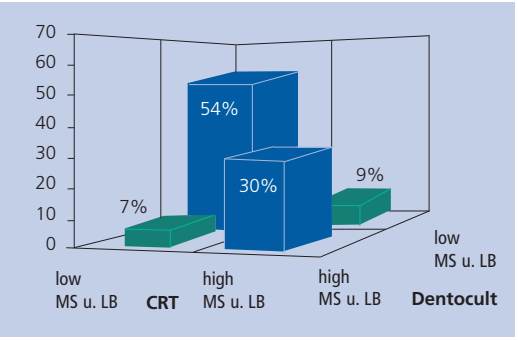

Figure 13: Comparative assessment of caries risk: Dentocult SM/Dentocult LB and CRT bacteria

both test methods, and 30% an equally high risk (Kneist et al. 1999) (Fig. 13). CRT bacteria reacts more selectively compared with conventional MSB-agar. An interfering concomitant flora only rarely occurs (Brailsford et al. 1998; Kneist et al. 1998). The bacterial yield of CRT bacteria for mutans streptococci, however, is comparatively even higher as a result of a modification of the agar (Kneist et al. 1998; Kneist and Richter 2001). The agar reacts more sensitively and is able to detect even low bacterial counts, which permits early detection of mutans streptococci (Kneist et al. 1999; Laurisch 1999). This characteristic is particularly useful when diagnosing small children.

Time for conducting the test

Saliva samples collected immediately after rising, before breakfast and before tooth brushing, show higher bacterial counts than samples collected at other times of the day (Bentley et al. 1988). This can be attributed to the fact that salivation comes virtually to a standstill during sleep, allowing bacteria to gather in the oral cavity. In the case of mutans streptococci, approx. 80 % of the findings based on saliva samples collected in the morning after breakfast and after tooth brushing correspond with the results for saliva samples collected in the afternoon. The correspondence of the findings for lactobacilli is approx. 90% (Togelius et al. 1984; Kneist 1998). Tooth brushing does not have a significant effect (El Nadeef and Bratthall 1991). Since the variation range is rather narrow, special recommendations regarding the optimum time of saliva sampling seems to be unnecessary (Kneist 1998). Patients need not refrain from having breakfast or brushing their teeth (Bentley et al. 1988). Without any special preservative, saliva samples remain relatively stable for two days at room temperature as regards the mutans streptococci and lactobacilli counts (Birkhed et al. 1981; Bentley et al. 1988).

CRT bacteria – step-by-step

Using CRT bacteria in the practice, has proven to be easy and time-saving. The patient chews a paraffin pellet in order to transfer the bacteria from the tooth surfaces to the saliva. Saliva is then collected in a suitable container. At this point, it is recommendable to determine the saliva flow rate and the buffer capacity with CRT buffer from Ivoclar Vivadent in order to complement the findings and work with economic efficiency. An $NaHCO_3$ tablet* placed in the test vial releases CO_2* when it comes into contact with moisture. This creates favourable conditions for bacterial growth. After the protective foil has been removed, quick working is essential. In other words, the agars should not be left to stand unprotected over extended periods of time. Draught, sneezing, or coughing near the agars must be avoided. Following these guidelines improves the stability of incubated tests. The development of mould can also be prevented in this way. Both agars must be entirely covered with saliva using a pipette without scratching the culture media. Bacteria will only grow in areas which have come into contact with saliva. Holding the carrier slightly oblique prevents the saliva from flowing off too quickly and favours the thorough wetting of the surface. The agar carrier is immediately placed in the test vial, which is tightly sealed. Two days of incubation in an incubator, e.g. Cultura- or CRT-incubator from Ivoclar Vivadent, at 37° C / 99° F are sufficient to allow the bacterial colonies to grow. This is an advantage over other systems, for which the test results are available at different times, i.e. after two days for mutans streptococci and only after four days for lactobacilli. Leaving CRT bacteria in the incubator for more than two days, e.g. over the weekend, will not cause any problems. Although the bacterial colonies may appear larger, the bacterial count is not affected. If needed for demonstration purposes, tests can be stored in the refrigerator for up to two weeks without any difficulty. To store them, the Plexiglas cover is quickly removed and disinfected. The test tubes are then resealed and placed in the refrigerator for storage. Used agar carriers are discarded after having been immersed in a suitable disinfectant or after autoclaving.

*Remark: $NaHCO_3$ = sodium hydrogen carbonate
CO_2 = carbon dioxide

Modifications of the procedure

A modification of the procedure permits the determination of mutans streptococci in plaque. Plaque is collected with a moist brush, loop, or tooth pick (Fig. 14) and carefully scraped off onto the blue agar. The available space is suitable for four parallel samples. To ensure appropriate moisture, a little water is added to the $NaHCO_3$ tablet, since there may not be enough saliva to generate the release of CO_2 when using this method. These samples are also incubated for two days.
This procedure is recommended for small children, who may not master the saliva collection procedure, xerostomia patients, and patients who have difficulties chewing. Other possibilities to collect saliva in small children may include the use of a pipette (Alaluusua et al. 1989) or a wooden spatula, which is turned on the tongue and subsequently scraped off on the agar (Laurisch 1999). Furthermore, xerostomia patients also have the option of rinsing their mouth with sterilized water (Krasse 1985). With the latter procedures, however, a lower bacterial yield must be expected.
The lactobacilli count in plaque can also be determined. For this purpose, an LB agar is inoculated. This measure is indicated to monitor the edges around brackets in orthodontic patients or the margins of restorations, as rough areas or suboptimal marginal seals represent ideal retention niches.

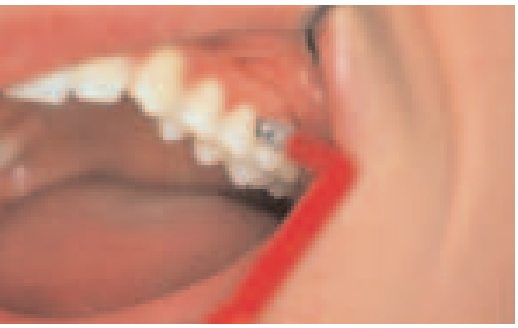

Figure 14: Collecting plaque

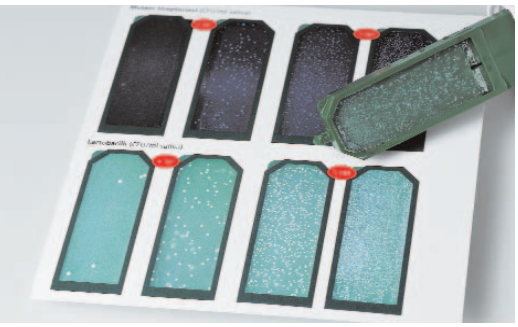

Figure 15: Evaluating the lactobacilli count on CRT bacteria by comparing the medium with the model chart

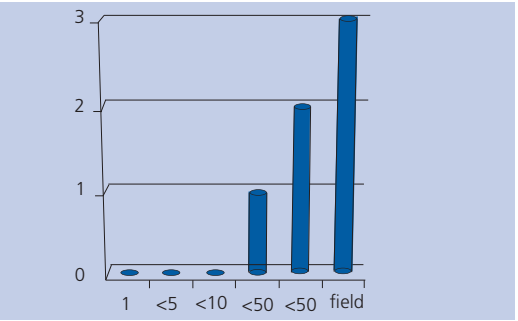

Figure 16: CFU of yeast colonies (C. albicans) on CRT® similar to CFU of lactobacilli on CRT®

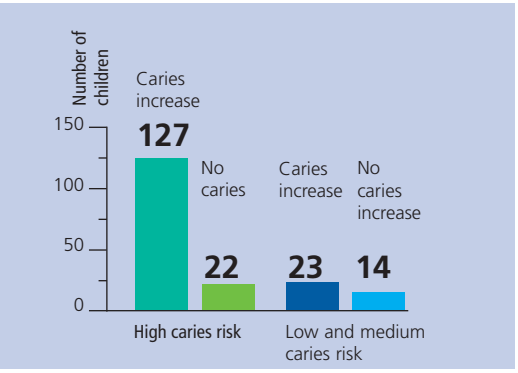

Figure 17: Caries increase forecast on the basis of the mutans streptococci and lactobacilli counts in saliva compared with the actual caries increase in 12- and 13-year olds (Kneist 1998)

Evaluation

Mutans streptococci occur as small blue colonies with a diameter of < 1mm on the blue agar, while lactobacilli grow as white colonies on the transparent agar. The comparison with the corresponding pictures in the model chart permits the assessment of the caries risk (Fig. 15). In this context, the differentiation between low and high caries risk is of clinical relevance (El-Nadeef and Bratthall 1991). Findings higher than 10^5 CFU of mutans streptococci and/ or lactobacilli per millilitre of saliva indicate a high risk (Krasse 1988; Andersson et al. 1993). If the transparent LB agar exhibits comparatively large creamy-coloured colonies, yeast has been growing on it. Similar to the bacterial count, the number of yeast cells present in a millilitre of saliva correlates with the density of colonization on the agar (Fig. 16) (Kneist u. Heinrich-Weltzien 2001). Similar to the saliva-based method, the examination of incubated plaque samples provides a semiquantitative indication of the microorganisms present (Kneist et al. 2001) and consequently enables the caries risk to be differentiated. Holding the agar carrier slightly oblique under a light source facilitates the evaluation. A magnifying glass may also be helpful.

8. Relationship between high bacterial counts and caries

High bacterial counts are, in any case, an indicator of a high caries risk, i.e. latent risk of developing caries. Given the multi-causal nature of caries, however, no reliable, general forecast can be made by examining only one etiological factor. (Holbrook et al. 1993). Therefore, caries does not necessarily have to develop if the effects of the protective factors are strong enough (Leverett et al. 1993). Should one of the important aspects deteriorate, however, such as the fluoride administration be reduced or the sugar intake increased, caries will develop (Bratthall 1996). Hence, new caries lesions will develop if high bacterial counts have been recorded (Kristofferson et al. 1985). An early control of the bacterial counts may contribute to a decrease in caries development in the long run, since corresponding measures can be introduced (Axelsson 1994).

Caries infection and future caries risk

A frequently heard argument is that clinical experience regarding previous caries infection in patients is more suitable to provide a reliable forecast of the future caries activity than saliva diagnostics (Verdonschot et al. 1994). Caries experience would however be a prerequisite for this type of forecast. But the basic objective should be to maintain oral health from the start. In this case, parameters which enable an objective evaluation of the risk to develop caries before any damage is visible must be used in order to be able to provide the necessary protection early enough: This is where caries risk tests come into play. Basically, caries infection indicates the fact that caries promoting conditions were present earlier. If they are not changed, they will lead to a progression of the disease. If a patient is treated according to a preventive treatment plan and if the number of restorations remains unchanged, the caries anamnesis provides little information as regards any possible future incidents (Kneist et al. 1998). Knowing the bacterial counts may enable dentists to spare their patients new lesions, which they would have underestimated if they had relied on clinical experience (Fig. 17). This is particularly valid for primarily healthy patients. The use of caries risk tests and the corresponding timely intervention measures would have helped protect 24 % of the children in a study conducted in Erfurt (Germany), who developed caries within four years. The actual number of children tested was approx. 1200 (Kneist et al. 1998). These results underline the fact that caries risk tests are much more than just a motivational aid. The combination of microbiological and clinical findings increases the sensitivity of caries forecasts to almost 100 % (Krasse 1988; Kneist et al. 1998).

Caries prevalence and bacterial counts

DMF-values* (DMFT or DMFS) document the caries prevalence. However, the summation of the components does not provide information about the share of carious, restored, or extracted teeth or tooth surfaces. This aspect explains why there is frequently no

*DMFT/ S = decayed, missing and filled teeth/ surfaces

correlation between DMF data and the bacterial counts (Loesche 1986). The picture changes if the number of carious teeth or surfaces is compared to the mutans streptococci findings of saliva. A clear correlation also becomes evident upon examination of plaque samples taken from carious areas (Loesche 1986; Babaahmady et al. 1998).

9. Caries risks tests – when and why

Figure 18: Explaining the CRT bacteria findings

The tests are contraindicated if cavities or four or more initial lesions are present. After treatment with antibiotics, at least two weeks should pass before the tests are applied. After the use of an antibacterial rinsing solution, the waiting period should be 12 hours. The use of CRT is useful in many cases.

The individual target groups for CRT comprise patients of all ages.

For primarily healthy and/or patients with restorations, who do not exhibit a caries risk, regular checks of the mutans streptococci and lactobacilli counts provide information with regard to current levels and possible increases in the bacterial counts (Kneist et al. 1998). This strategy offers the possibility of taking early preventive measures before the caries has become clinically manifest. Mothers constitute another important target group. It has been shown that children of mothers with high bacterial counts tend to demonstrate high bacterial counts themselves (Köhler et al. 1983). It appears that not only the sugar intake and number of active carious lesions of the mother are indicators of a child's caries risk, but also the mother's level of mutans streptococci (Smith et al 2002). Caries-free children usually present with $< 10^5$ CFU of mutans streptococci per millilitre of saliva (Krasse 1988). Special preventive pre- and post-natal programs may significantly improve the health of both mothers and children (Günay et al. 1998).

The evaluation of microbiological data is also recommended prior to orthodontic treatment, since the caries risk tends to increase dramatically in patients with high bacterial counts after the placement of brackets, due to the difficulties in performing adequate oral hygiene. To compliment the treatment plan, plaque in the vicinity of the bracket margins should also be checked, as these areas are particularly difficult to clean. If an increase in the bacterial counts occurs, preventive measures can be taken in a timely fashion, helping avert the premature termination of orthodontic treatment - which might otherwise have been necessary. Furthermore, caries risks tests are recommended before the placement of high-quality restorations or tooth replacements and for monitoring the quality of such work.
Identifying high risk patients is of particular importance. These patients can be easily and quickly identified and treated in a targeted fashion in the course of large-scale screenings, which also has a favourable effect on the overall costs in the long run (Newbrun et al 1983). Furthermore, a caries 'polarization' phenomenon has been observed in countries in which the caries incidence has been substantially declining over the past years. In these countries, approx. 20% of the population suffer from approx. 80% of all the caries (Micheelis and Reich 1999; Brändle et al. 1991). The antimicrobial treatment of these risk patients, e.g. with Cervitec, a chlorhexidine-containing varnish from Ivoclar Vivadent, can be optimally planned and monitored by means of CRT bacteria.

The DMFT value in adolescents has been falling in countries such as Switzerland for many years, however initial signs of a reversal in this trend have been noticed (Kuster et al 2002). Patients and parent awareness of the origin of caries and their sense of responsibility for maintaining oral hygiene should be heightened in order to prevent the caries prevalence from rising again.

CRT bacteria is an excellent basis for explaining to all patients, the complex and inter-related causes of caries; and presenting to them the individual treatment options the practice can offer (Fig. 18). Individualized patient care is improved and patient loyalty promoted.

Microbiological examinations are therefore an important diagnostic tool for dentists who strive to maintain the oral health of their patients. Examinations with the help of chair-side tests, e.g. CRT bacteria, have shown to be easily conducted. Furthermore, they are less expensive than conventional microbiological methods (Kneist et al. 1998; Newbrun et al. 1983). Additionally advantageous, the tests can be conducted by trained personnel in field conditions.

10. CRT bacteria – the basis for targeted treatment

Used in combination with clinical inspection, CRT bacteria optimizes the individualized treatment plan. It goes without saying that cavities and plaque retention sites, e.g. protruding restoration margins, should be eliminated beforehand. Fissure sealing, e.g. with Helioseal F from Ivoclar Vivadent deprives the pathogenic bacteria of further niches. Lactobacilli in particular, lose an important breeding ground in this way. Antimicrobial therapy with chlorhexidine-containing preparations, e.g. Cervitec from Ivoclar Vivadent, in combination with professional fluoride treatment, e.g. Fluor Protector, the fluoride-containing varnish from Ivoclar Vivadent, also forms part of the established treatment methods for patients with high bacterial counts (Axelsson et al. 1994). Regular professional tooth cleaning, e.g. with Proxyt from

Ivoclar Vivadent, as well as the thorough education of patients regarding effective oral hygiene measures to be performed at home and appropriate eating habits also belong to the recommended treatment measures for risk patients. Bite wing X-rays for early identification of proximal caries, personalized recalls involving clinical inspections and the re-evaluation of the microorganism findings, as well as the evaluation of the salivation rate and buffering capacity with CRT buffer from Ivoclar Vivadent, will help to maintain the health/ existing status of the teeth (Krasse 1985; Anderson et al. 1993; Kneist et al. 1998). The personalized care and the painless treatment methods enabled by the early recognition of the caries risk with CRT bacteria, form the basis for a solid, trusting and long-lasting relationship between patients and their dental teams.

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Schaan, November 27, 2002
Dr Gabriele David;
updated by Cornelia Weigand

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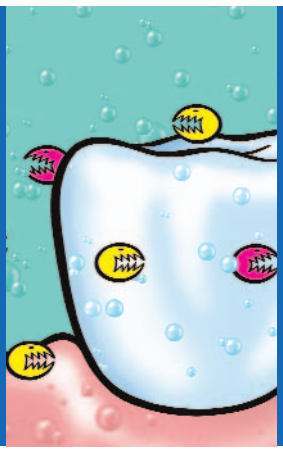
Caries Risk Tests

- → provide a basis for the early identification of caries risk patients.
- → provide a basis for customized treatment measures.



CRT Caries Risk Test

Evaluation

		Low Caries Risk	High Caries Risk
Findings	Plaque accretion		✗
	Initial lesion		✗
	Mutans streptococci (CFU/ml saliva)	$< 10^5$	$\geq 10^5$
	Lactobacilli (CFU/ml saliva)	$< 10^5$	$\geq 10^5$
	Salivation rate (ml saliva/min)	≥ 1	< 0.7
	Buffer capacity	high	low

Recommended treatment

				in particular
Dental practice	Targeted recording of case history		✗	
	Check-ups	✗ 2x/a	✗ 4-6x/a	
	Re-assessment of caries risk	✗	✗	
	Bitewing X-ray for the early detection of proximal caries	✗	✗	
	Restoration of carious lesions	✗	✗	
	Removal of plaque retention sites	✗	✗	
	Protection of exposed cervicals	✗	✗	
	Fissure sealing		✗	
	Topical fluoride application	✗ 2x/a	✗ 4-6x/a	
	Motivation and instruction for oral hygiene improvement	✗	✗	
	Professional tooth cleaning	✗	✗	
	Topical application of chlorhexidine		✗ ✗	
	Nutrition counselling		✗	

Measures

At home	Dentifrice containing fluoride Cleaning of interdental spaces	✗	✗
	Rinsing solution or gel containing fluoride		✗
	Preparations with chlorhexidine		✗
	Preparations with bicarbonate		✗
	Balanced diet	✗	✗
	Hard-to-chew food		✗
	Sweets and chewing gum with sugar substitute		✗

Picture: CRT Therapy Scheme, Art No 553908

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