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## Taking personal oral hygiene to a new level

*With a steadily growing amount of health and beauty-conscious people in Asia, more and more patients have recognized oral health as a very vital factor for overall physical health and general wellbeing.*

*This awareness has rapidly generated a much greater demand for preventative measures, for cosmetic perfection and thus for a broader supply of high-end dental care products. Over recent years patients have become significantly more aware of the impor-*

*tance of personal oral hygiene. Most patients rely on their dentist, orthodontist or general health practitioner to be updated and informed about latest developments and improvements on the oral health sector.*

*Taking this into account, we would like to introduce PEARLS & DENTS – an innovative, award-winning, medical toothpaste featuring a unique, highly-effective, world-patented Pearl-Cleansing-System.*



**Prof. Dr. Sander**

## The Innovation in Dental Hygiene

PEARLS & DENTS is an innovative, high-end medical toothpaste developed and clinically proven by one of the leading German professors for orthodontics, Chairman Prof. Dr. Franz G. Sander of the University of Ulm, and manufactured in Germany since 1997 by the well-established and traditional manufacturer of medical toothpastes, Dr. Liebe.

PEARLS & DENTS combines a unique mechanical cleansing method with all the long-term proven benefits of high-end medical toothpaste. Its world-patented "Pearl-Cleansing-System" is highly effective against plaque and stains, but incomparably gentle on the enamel and gums.

PEARLS & DENTS contains differently sized, essential oil-soaked polymer pellets (Fig.1), which are agitated by the brush and thus thoroughly clean and polish even in narrow inter-dental spaces and in otherwise hard-to-reach areas: below the gum

*" Even if we take into account that the actual cleansing environment is different from an in-vitro environment, it should raise thought that Savil et al were able to determine, that a toothpaste with an RDA value of 75 can cause dentine abrasion of up to 51 µm when used twice a day for a period of 3 weeks."*

Prof. Dr. F.G. Sander, University of Ulm

line, in gingival pockets and at brace edges of fixed orthodontic appliances. The pellets also gently massage the gums, leaving them healthy and strong.

## Hard on Plaque & Stains - Gentle on Enamel & Gums

Assuming that these days people live longer than in previous generations, a toothpaste should be highly effective against tooth decay and enhance the aesthetic appearance, but should not contribute to an un-safe abrasion of the enamel and dentine. With a rapidly growing trend towards

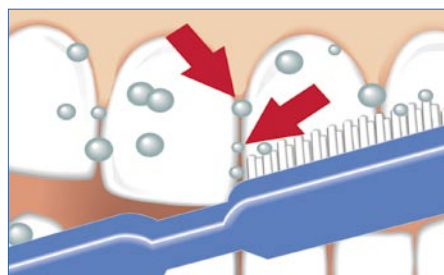


Fig.1: The Pearl-Cleansing-System: Tiny soft essential oil soaked cleansing pellets thoroughly clean and polish

powerful electronic toothbrushes, low abrasiveness becomes an even more vital factor. Therefore PEARLS & DENTS' unique Pearl-Cleansing-System has been carefully optimized: the cleansing pellets effec-

tively remove plaque and stains whilst its low RDA-Value\* of 45 guarantees that the enamel, composite and other permanent fillings, crowns, caps, veneers, implants

and bridges remain unaffected, as opposed to most common toothpastes with conventional bleaching or sanding agents.

As shown in Fig. 2, PEARLS & DENTS is remarkably less abrasive than most leading toothpastes on the market - even including leading children's toothpaste.

In the enclosed clinical study on the abrasive effects of common German toothpastes (page 9-13), PEARLS & DENTS (0,3 µm) was proven to be 43 times less abrasive than Blendi® Children's Toothpaste (12,9 µm / abrasion of dentine and enamel measured in average roughness depths - µm ), whilst still cleaning nearly three times more effectively; as clearly demonstrated by the enclosed scientific development study of PEARLS & DENTS (page 4-8).

## Whitening without Bleaching or Sanding

PEARLS & DENTS is free of bleaching agents or any other aggressive whitening and sanding agents, but still reaches a remarkable whitening effect. Through complete plaque and stain removal and gentle polishing, the enamel retains its youthful white and natural smoothness.

PEARLS & DENTS is especially good news for patients who have already started the cycle of dental bleaching: it is commonly known, that with every whitening session teeth tend to get stained faster and are more

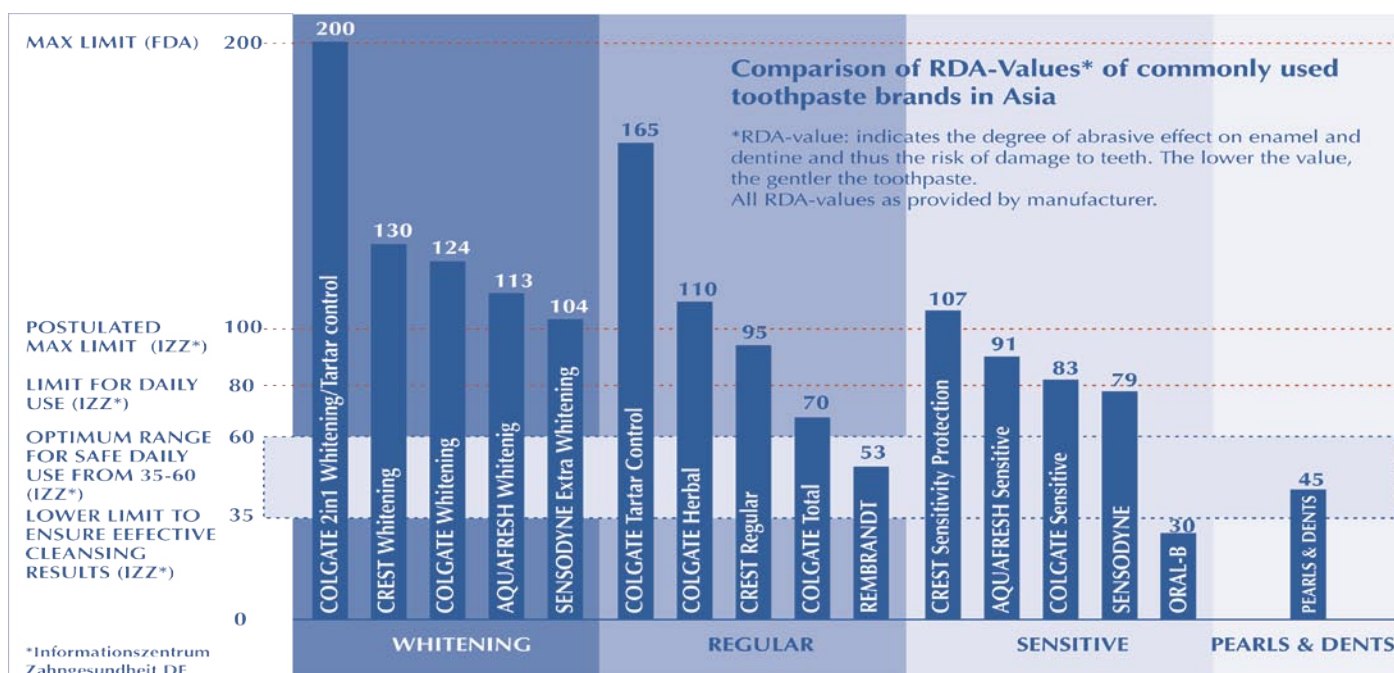


Fig.2: PEARLS & DENTS features a very low RDA-Value of only 45, but cleanses more than twice as efficient than other tested products. Its innovative PEARL-CLEANSING-SYSTEM cleans thoroughly and fast, especially well in otherwise hard-to-reach areas: in narrow inter-dental spaces, under the gum-line and under brackets and bows in case of fixed orthodontic appliances. With a brushing movement of 60 seconds, the in-vitro tests showed a 2.75 times better cleansing effect (Clinical Development Study- page 4-8). With its optimum RDA-Value, PEARLS & DENTS is highly recommendable for daily use.

prone to tooth decay, due to the roughened enamel.

Since PEARLS & DENTS has been designed for fast and careful restoration of a smooth and well-polished tooth surface, it is highly beneficial after bleaching treatments.

By restoring the dental surface, PEARLS & DENTS remarkably reduces harmful effects of cariogenic bacteria on the enamel and dentine and successfully prevents the re-formation of deposits and stains – a truly tangible improvement.

### State-of-the-art Medical Ingredients

PEARLS & DENTS' highly effective Pearl-Cleansing-System in combination with time-tested and clinically proven, premium medical ingredients and valuable natural agents, ensures the best protection possible:

#### • Reduction of Plaque Build-up

Xylitol is a natural sweetener and acts against the build-up of plaque and successfully impedes the growth of cariogenic bacteria.

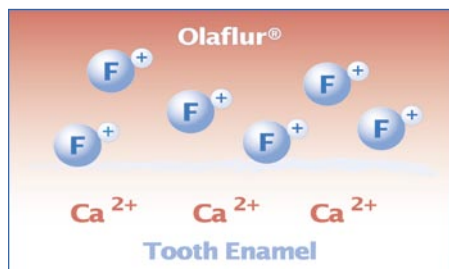


Fig.3: PEARLS & DENTS contains Olaflur (Amine-Fluoride 800ppmF and Sodiumfluoride 400ppmF), which proves particularly efficient in regards to fluoridation of teeth

#### • Complete Protection with Olaflur

Olaflur is a highly-effective double-fluoride system with Amine- and Sodium-Fluorides and is particularly efficient in mineralising and protecting the teeth. Its special chemical structure (wetting agents) enables Olaflur to accumulate quickly and effectively on teeth surfaces, where it promotes the formation of a fluoride-containing protective layer. Olaflur hardens and strengthens the enamel, thus successfully protecting the enamel from harmful acidic substances.

#### • Healthy Gums

A combination of Panthenol (Pro-vitamin B5), Bisabolol, chamomile extracts and es-

sential oils provides a protective barrier for the gums and provides fresh breath.

### Special care for patients with special needs

Clinical studies (page 4-8) have shown that PEARLS & DENTS is the ideal personal dental hygiene product whilst undergoing ortho-



*“PEARLS & DENTS is particularly suitable for all people undergoing orthodontic treatment. Since PEARLS & DENTS has been designed for fast and careful restoration of a smooth and well polished tooth surface, it is also highly recommended after the removal of all types of orthodontic braces”*

Prof. Dr. F.G. Sander, University of Ulm

odontic treatment and in case of composite and other permanent fillings, crowns, caps, veneers, implants or bridges.

PEARLS & DENTS penetrates deep into the problem zones at the brace edges, under the bows, below the gum line and in gingival pockets, common in most patients with dental prostheses.

Since PEARLS & DENTS has been designed for fast and careful restoration of a smooth and well-polished tooth surface, it is also highly recommended after the removal of all types of fixed orthodontic appliances.

### PEARLS & DENTS is suitable for:

- All health-conscious people
- Children (above 6 years) and adults undergoing orthodontic treatment
- Patients with crowns, implants, bridges and all other types of dental prostheses
- After dental bleaching
- After prophylactic dental sealing
- Coffee & Tea-drinkers
- Red-wine-lovers

### Application

PEARLS & DENTS should be used as a regular toothpaste, and can even be applied more frequently due to its low RDA-Value. For best results, teeth should be brushed with PEARLS & DENTS at least twice a day, mornings and evenings, for 3 minutes at a time.

## PEARLS & DENTS®

*Time tested and clinically proven at the University of Ulm, Germany since 1997*

*Endorsed by most German orthodontists and dentists.*

*Manufactured to highest medical standards by Dr. Liebe, Germany*

*Official Supplier LUFTHANSA First Class*

*Highly recommended and adored by customers.*

*Available in Asia at participating dentists, orthodontists and health clinics*



# Development and clinical trial of an innovative teeth-cleansing system

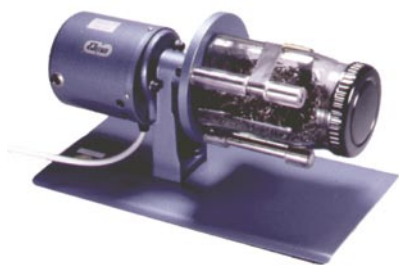
Prof. Dr. Franz-Günter Sander

*The following study describes the development of a so far unknown, truly innovative teeth-cleansing system in toothpaste and gives an account of first clinical trials led by the Department of Orthodontics at the University of Ulm, Germany.*

*The innovation is based on small cleansing pellets, which are non-abrasive but still big enough to agitate one another and hence effectively clean. The new system is to be particularly effective in the cleansing of teeth with brackets and bridges, where in many cases even specialised brushes fail to reach.*

## Introduction

The foundation of improved oral hygiene is still the daily practice of brushing teeth with a toothbrush as well as toothpaste or tooth powder. Patients with narrow inter-dental spaces, misaligned teeth and patients undergoing orthodontic treatment with fixed appliances and brackets need considerably more time to efficiently clean their teeth.



**Fig 1:** Balling Drum / as used in industrial applications

Benarius et al. (1) were able to prove, that the cleansing effect was neither dependant on the brush nor the toothpaste used. A similar result could be achieved by using water only. However, this cleansing effect was only achievable under a much longer expenditure of time. Beyeler and Moser (2) found that the time to reach a desirable cleansing effect could be reduced by 20-40% with the use of toothpaste. Gülzow and Busse (6) assume a 30% reduction in time. However it is important to note, that the toothpastes used should contain a minimum in abrasive cleansing agents, as,

according to Schönauer and Berghult (8), the likelihood of development of wedge-shaped defects and Stillman's cliffs are considerably increased. Franz (4,5) found out, that all toothpastes available in the German market are safe to use.

Many toothbrush manufacturers have addressed the problems associated with narrow inter-dental spaces by introducing toothbrushes with wave-like bristle heads and specific inter-dental brush heads. The reason for this is likely to be explained by the fact that an inter-dental space can only be cleaned if the bristles actually reach into the gap. Apart from that, specific brushing techniques may play a role.

The achievable cleansing effect of regular daily dental care depends on the following factors:

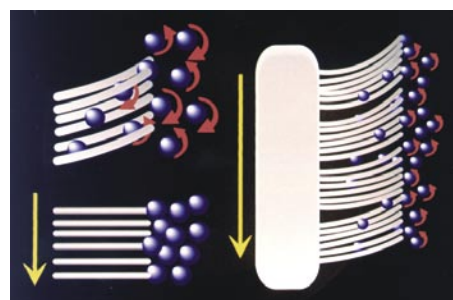
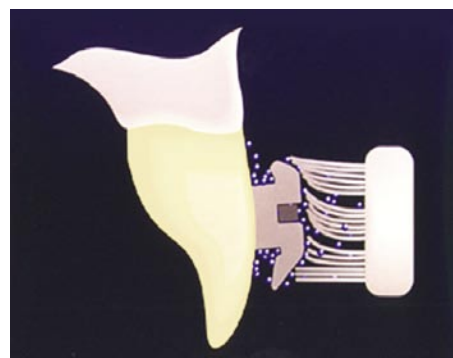
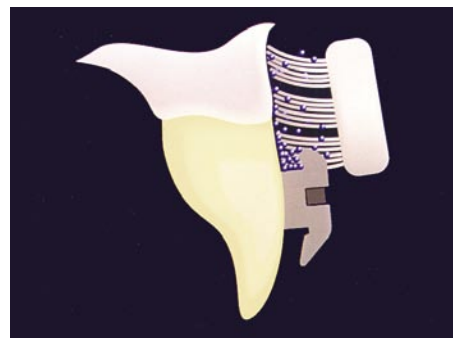
1. The level of dental cleansing knowledge of the patient and the used brushing method
2. The time spent on daily tooth cleansing
3. The contents and qualities of the toothpaste
4. The brush used for cleansing

Clinical studies have shown, that the dental cleansing knowledge of a patient and its associated motivation has to be monitored on a regular basis. Many patients however, fall back into their own routines shortly after having acquired knowledge of a new brushing method.

The time spent on daily dental cleansing

could be monitored by the simple use of timer clocks. But from experience we know that such measures are commonly neglected after a short period of time.

The contents and qualities of the toothpaste can considerably influence the suc-



**Fig 2,3,4:** The addition of copolymers to the toothpaste enhances the cleansing effect drastically. The polymer pellets are agitated by the brush and hence transported into the hard-to-reach areas, such as under brackets and in narrow-inter-dental spaces



**Fig 5:** Brushing Machine: nine brushes are simultaneously brought into motion



**Fig 6:** Each toothbrush carries a weight of 100g

cess of cleansing the teeth, even without the addition of abrasive agents.

In most cases the special design of multiple toothbrushes requires the patient to use different brush heads to clean teeth effectively. Most patients do not keep up with this practice due to the obvious inconvenience.

Considering the mentioned factors, emphasis should be put on the enhancement of the toothpaste to achieve a better cleansing result.

## Aims & Objective

The hitherto existing briefing in oral hygiene can be summarised as follows:

1. After an initial patient briefing on brushing techniques and cleansing tips the patient is generally motivated to apply the techniques. However, after a few days, most patients lapse into their old routine. Only repetitive briefings can lead to an anticipated improvement of oral hygiene.

2. At first the duration of daily teeth cleansing remains coherent with the initial briefing given by the dentist to the patient, however, after a short period of time the duration decreases significant-

ly. The patients usually come up with a number of excuses and explanations.

3. Recommendations by a dentist or orthodontist on which toothpaste to use are generally well received and followed by patients.

4. The choice of which toothbrush to use is commonly influenced by the doctor's recommendation as well as by advertisements.

On these accounts, apart from the permanent briefings on brushing techniques, the effectiveness of the toothbrush and the toothpaste are especially important in achieving permanently effective dental cleansing results. In science and technology it has been common practice for decades to clean especially difficult objects by using a balling drum or tumbler (Fig.1). Such devices contain the object to be cleaned or polished as well as cleansing additives in the form of granules or other polishing materials. Depending on the object to be cleaned, the balling drum or tumbler contains steel granules, steel particle or soft polymer pellets. These polymers or copolymers can be even or rough in surface.

In the jewellery industry it is common to use very soft polymers for polishing gold and other precious metals to avoid abrasion on the surface.

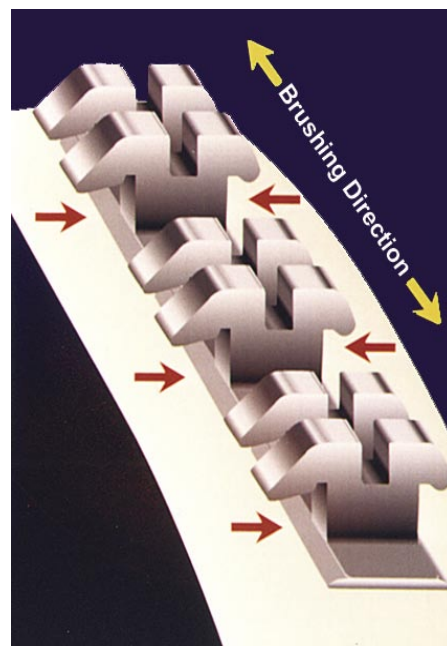
Through these polymers it is possible to polish inaccessible places as well.

The objective of this study was to determine whether these findings are transferable to the cleansing processes of teeth, inter-dental spaces and brackets (Fig.2-4). The toothbrush is herein taking the role of agitating the polymers in order to clean inter-dental spaces.

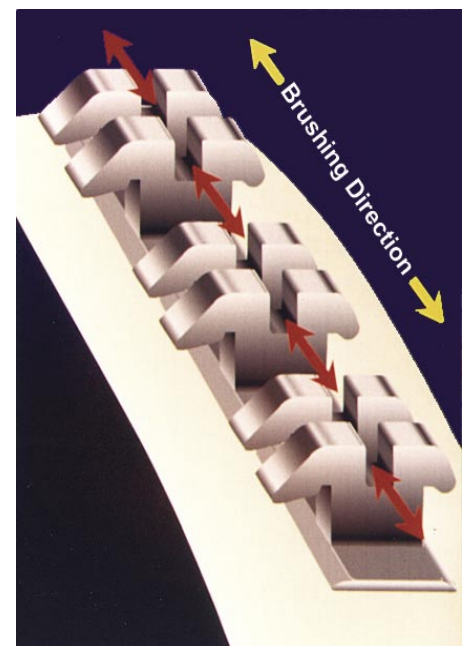
## Material & Methods

For the in-vitro tests we used a time-tested and proven toothpaste with Amine- and Sodium Fluorides, Chamomile extracts, Panthenol, Bisabolol and Xylitol and added Ethylene Vinyl Acetate Copolymers. The effects of this modified toothpaste was to be tested against two known toothpastes. For this purpose we constructed a tooth-brushing machine (Fig.5), which held a total of nine toothbrushes, which were simultaneously agitated. Each brush head is moving horizontally by 15 mm. The brushing frequency of 3,3 Hz was determined by the average brushing frequency of ten test persons. The simple horizontal movement was chosen due to the fact, that on average it resembles the brushing movement used by most people. In order to guarantee equal pressure on the tested specimen, each brush head was equipped with a weight of 100g (Fig. 6).

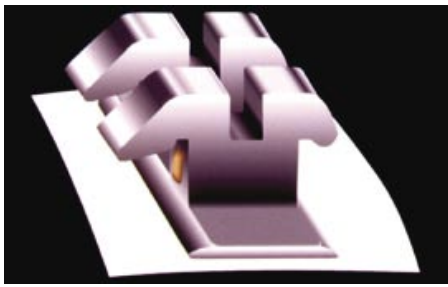
Each specimen stage was equipped with brackets and bows to simulate the brush-



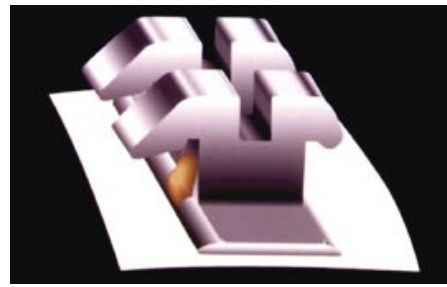
**Fig 7:** Category A: describes the cleaned surfaces perpendicular to the brushing direction



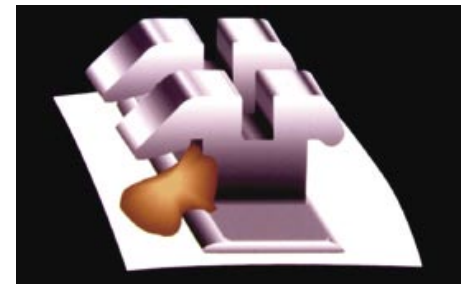
**Fig 8:** Category B: describes the cleaned surfaces parallel to the brushing direction



**Fig 9:** Index 1 - only very light residues are visible



**Fig 10:** Index 2 - light residues remain



**Fig 11:** Index 3 - medium stain residues

ing effects. These were then submerged in a hot liquorice solution and dried in an oven at 100°C for a duration of 60 minutes. The liquorice solution, which disperses into all inter-dental spaces, symbolises the staining and contamination of teeth and brackets.

## Brushing Method

After the application of toothpaste to the brush alongside the bristle direction, 1ml demineralised H<sub>2</sub>O was added and the brushing mechanism was activated for 30 sec., 60 sec., 90 sec. and 180 sec. respectively. These brushing durations were applied to all three toothpaste specimens. Each brushing test was carried out with new toothbrushes to minimize a falsified toothpaste result.

With the help of a microscope the results were evaluated after each brushing test. The surfaces under the brackets were evaluated and measured in count. Each combination was tested three times and results were averaged for evaluation.

Due to the fact that the toothpaste was

to be tested on account to its ability to clean inaccessible places, only the surfaces not directly reached by the bristles were evaluated.

## Results

The evaluation of the cleansing effect was divided into two criteria. Category A (Fig.7) describes the cleaned surfaces perpendicular to the brushing direction and category B (Fig. 8) describes the cleaned surfaces parallel to the brushing direction. Therefore, category A represents the cleansing effect underneath the bracket wings, whereas category B represents the cleansing effect in the inter-dental spaces and between the brackets.

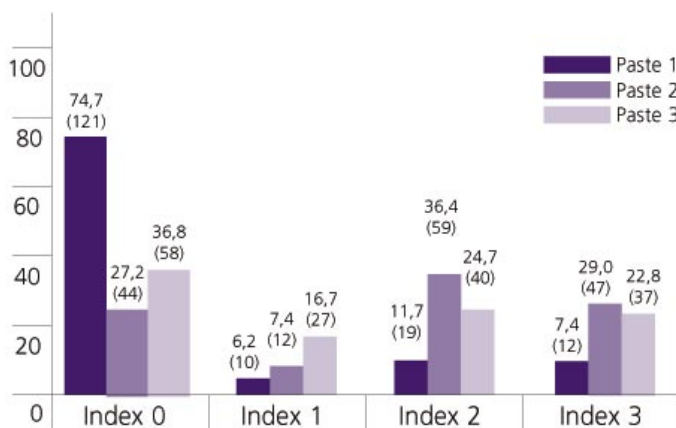
The cleansing effect itself was categorised into four indices (Fig 9-11):

- Index 0: entirely cleaned surface
- Index 1: very light stain residues
- Index 2: light stain residues
- Index 3: medium stain residues

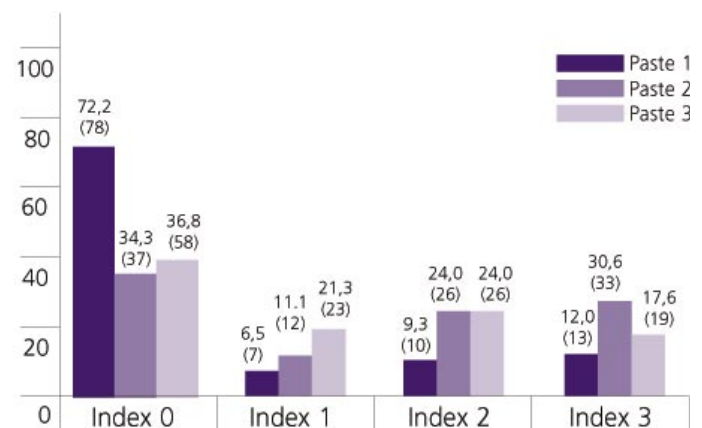
Cleansing Effect after 60 seconds:

The results for category A (perpendicular to brushing direction) show a remarkable cleansing capability for paste 1 (PEARLS & DENTS); 121 of 162 possible surfaces are entirely cleaned (Fig.12) and only 12 of 162 still show medium stain residues. The results for the two reference pastes 2 and 3 were very different. They both showed noticeably more heavy stain residues after 60 seconds. The brushing effect in category B (parallel to the brushing movement) of paste 1 shows that 78 of a total of 108 possible areas are entirely cleaned (Fig.13) and only few medium stain residues can be found. The result in category B for the reference pastes 2 and 3 was again very different from PEARLS & DENTS.

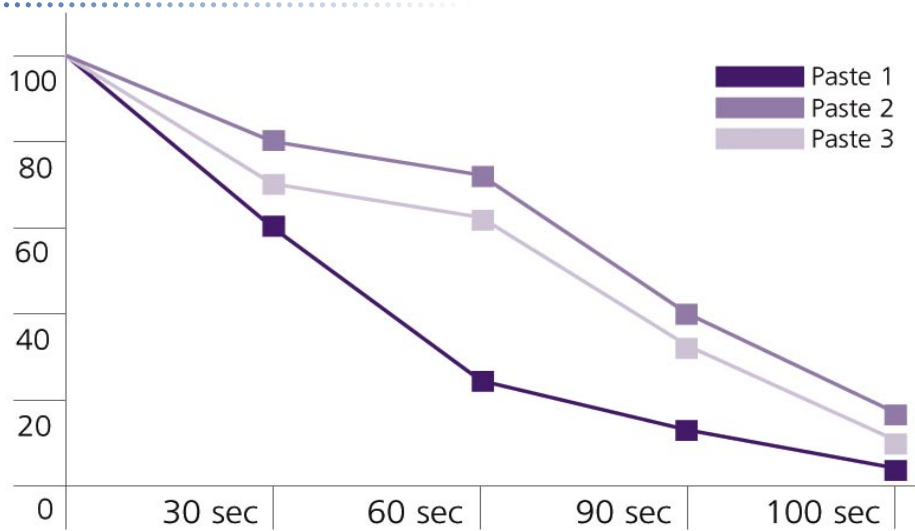
As previously stated by Benarius et al. (1), not only the cleansing effect is increased with an extended brushing duration, but also the ingredients of toothpaste become less influential. Figure 14 shows the cleansing effectiveness of all three tested toothpastes in relation to the brushing duration as described by Lutz (7).



**Fig 12:** The results achieved by the three tested pastes are compared after a brushing duration of 60 seconds. Paste 1 (PEARLS & DENTS) thoroughly cleans 74.4 percent of the contaminated surfaces. The other pastes produce notably lower results.



**Fig 13:** After the 60 second test, paste 1 (PEARLS & DENTS) achieves to entirely clean 72,2 percent of all contaminated surfaces. All other pastes achieve significantly lower scores.



**Fig 14:** If the brushing time is longer than 90 seconds, the toothpaste composition becomes less influential on the cleansing effect. The special cleansing characteristics of the featured toothpaste PEARLS & DENTS are especially evident in brushing times below 60 seconds where the main effect is evident.

It is clearly visible, that PEARLS & DENTS has its advantageous cleansing qualities in particular within the first 90 seconds. Especially the result after 60 seconds represents PEARLS & DENTS superior qualities.

To prove the statistical relevance of the results, all test data are entered into a contingency table for comparison.

If these results are applied to the cleaned surfaces respectively, we can conclude as follows:

1. In the brushing test of 60 seconds, PEARLS & DENTS cleans 2.75 times better than paste no.2 and twice as good as paste no.3. This result is relevant to the areas perpendicular to the brushing movement.

2. In the brushing test of 60 seconds, PEARLS & DENTS presents a 2.1 times better effect than paste no.2 and a 2 times better result than paste no.3. This result is relevant to the areas parallel to the brushing movement.

## Discussion

It is certainly without controversy that dental cleansing with water and a toothbrush only can achieve a similar effect to cleaning with toothpaste and toothbrush. The difference in regards to the cleansing effect however is a significantly longer brushing time when omitting toothpaste.

It should also be indisputable, that toothpaste ingredients such as fluorides and Xylitol provide effective protection from caries.

In most people the brushing techniques used and time spent on dental hygiene are only in very few cases according to the desired guidelines of a dentist. Taking into account challenging conditions such as narrow inter-dental spaces, fixed orthodontic appliances, reduced brushing duration as well as incorrect brushing techniques, the achievement of a thorough dental cleansing is indisputably a very important concern.

Aesthetically aligned teeth, as in the case of orthodontic treatment, can understandably only be beneficial to the patient as well as the orthodontist, if the teeth are kept free of caries and unsightly stains during the course of treatment.

The addition of soft polymer pellets to a time tested and clinically proven medical toothpaste can obviously enhance the cleansing effect as follows:

1. The dental cleansing duration is remarkably shortened with a toothpaste containing polymers, or the toothpaste containing polymers cleanses much more efficiently under a given time frame.

2. Through the addition of polymer pellets, the toothpaste cleans even in areas that are not directly reached by the bristles.

3. The marginal shore hardness of the

polymer pellets (a=90) additionally eliminates the chances of enamel abrasion

4. The ingredients of the existing medical toothpaste remain unchanged, providing time tested and proven protection against caries and tooth decay.

Conclusively, it would be incorrect to explain to the user (patient) that the use of PEARLS & DENTS can decrease the brushing time. The better approach is clearly to explain that PEARLS & DENTS cleans much more thoroughly and efficiently than other toothpastes within the same time frame. The industrially known roller-burnish-effect does not only apply during the actual brushing of teeth, but as well when the patient rinses the mouth after brushing.

## Summary

The cleansing effect could be considerably increased by adding ethylene vinyl acetate copolymers to time tested and proven medical toothpaste. Narrow interdental spaces as well as surfaces under brackets and arch wires as they exist in patients undergoing orthodontic treatment, are not very accessible places, but are considerably better and more thoroughly cleaned under the use of PEARLS & DENTS.

With a brushing movement of 60 seconds, the in-vitro tests showed a more than two times better cleansing effect than other tested toothpastes. Patients using the new PEARLS & DENTS toothpaste achieve a thorough and fast tooth cleansing effect in inter-dental spaces and in places that are difficult to reach in the case of a fixed appliance. Consequently, the application of PEARLS & DENTS toothpaste cannot only be recommended to patients wearing a fixed appliance – it is also especially suited for a normal, daily application.

The application of PEARLS & DENTS can also be recommended after the removal of fixed appliances because of its special cleansing and polishing qualities. Without abrasion on the enamel, an especially well-polished surface occurs during its application.

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# Abrasive Effects of Common German Toothpastes for Adults and Children – Comparison

Ch. Sander, F. M. Sander, H. C. Wiethoff, F. G. Sander

***Most people nowadays have included dental hygiene as part of their daily routine, brushing their teeth at least twice a day. Some patients literally “scrub” their teeth whilst brushing. The following study demonstrates the abrasive effect on the enamel and dentine of the most common German toothpastes.***

## Introduction

Microbial plaque plays a dominant role in the development of caries and periodontal inflammations. Numerous scientific studies have proven a strong cohesion between personal oral hygiene and the development of dental diseases. [7,9,15,16]

It is clearly indisputable that the use of toothpaste is a vital part in oral hygiene. Teeth can indeed be cleaned with a toothbrush and water only, however, the user would miss out on valuable ingredients, such as various abrasive components to increase the cleansing effect.

In addition toothpastes contain valuable, active agents to strengthen teeth and to impede the growth of microbial bacteria in the oral cavity [4] and on the tongue.

Apart from emphasizing the benefits of various toothpastes, it is important not to conceal their strongly varying abrasive effect on the dentine and enamel [8,12]. This abrasion is expressed through the terms RDA-Value (Radioactive Dentine Abrasion) and REA-Value (Radioactive Enamel Abrasion). It is assumed that high RDA/REA-Values are equivalent to strong abrasion on enamel and dentine [3,10], whereas low RDA/REA-Values represent a less abrasive effect of the toothpaste.

Bleaching toothpastes which claim to whiten teeth and to eliminate stains and discolorations (mainly caused by tea, coffee, red wine, nicotine and numerous

other dietary substances) usually have a considerably high RDA-Value, i.e. 100 or more, and are therefore highly abrasive on teeth.

Toothpastes with a low RDA-Value generally feature lower abrasiveness but however do not clean sufficiently. In-vitro brushing tests have led us to conclude that the RDA-Value should not exceed 50 in order to keep the abrasion at a safe level.

However, to achieve a sufficient cleansing effect, toothpastes should have a minimum RDA-Value of 35. Abrasion does not only affect the enamel and dentine, but also fillings and, in particular, dental fissure sealants and composite fillings.

For a number of reasons, dentine abrasion caused by toothpaste plays a role in dental hygiene:

1. Assuming that people these days live longer than in previous generations, toothpaste should not contribute to an abrasion of the enamel and dentine.
2. Strong abrasion can lead to exposed dental necks and wedge-shaped defects.
3. A high abrasion leads to increased disposal of mercury in patients with amalgam fillings.
4. The intake of acidic food and drinks, as for example orange juice, causes the enamel to temporarily “soften”. If teeth are brushed too shortly after the enamel has had time to be re-mineralized, we can expect a higher abrasion on teeth [2,5,13]

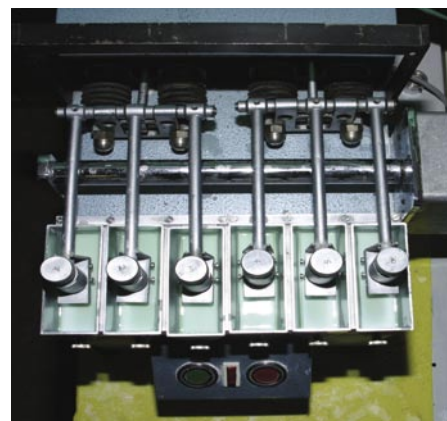


Figure 1: Brushing Mechanism

## Experimental Setup

Addy M. et al [1] were able to determine the Dentine Abrasiveness of two types of toothpaste after an application of five and ten days.

Today, there is a vast variety of filling materials used in patients. Herein composite fillings made of synthetic materials are taking an ever-increasing share. Therefore the tests carried out measured the abrasion on a polymer surface. The polymer surface is softer than the enamel or dentine and thus can show the abrasive effects more clearly. This practice shall under no circumstances replace the study of RDA-Values, but provide an opportunity to summarize the abrasive qualities of toothpastes.

To measure the abrasion PMMA (Plexiglas®) [6] was used during the study. The PMMA plates were brushed by application of different toothpastes. During all



Figure 2: Toothpastes tested in the study

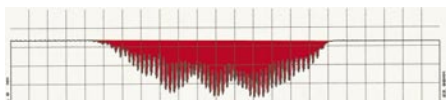


Figure 3:  $R_{max}$  / red area shows the loss of surface substance

tests the brush head of a medium-firm Elmex® 29 (Polyamide filaments) toothbrush was moved 50,000 times forwards and backwards.

The pressure used was equal to 2 N. This was ensured by the use of a 200g weight affixed to the brushing mechanism (Fig.1). For the tests, the toothpastes were mixed with Aqua dest. (As per EN ISO 11609). Apart from the tests with diverse toothpastes, tests with only Aqua dest. were additionally carried out; all other tests corresponded to ISO 11609.

The brushing processes took approximately five hours each. The evaluation of abrasion was carried out with the help of a surface analyser that determined the roughness of the PMMA plate surface. The machine used was a Profilometer Hommel Tester T 2000.

#### Abrasion caused by the toothbrush only (Elmex® 29):

During the blank test, the brush head, with water acting as the cleansing agent, was moved over the PMMA surface. The abrasive impact on the surface was insignificant ( $R_a$  0,2  $\mu\text{m}$  and  $R_{max}$  2,87  $\mu\text{m}$ ).

The standard of comparison in all tests was the reference paste composed according

to EN ISO 11609, which is assigned to be of average abrasive quality. According to the norm the abrasiveness of any toothpaste should be maximal 2.5 times (dentine) and maximal 2 times (enamel) the value of the reference paste.

The following toothpastes were investigated (Fig. 2):

- Reference Paste (EN ISO 11609)
- Blend-i® (child) - Procter & Gamble
- Blend-a-med mediclean® - P&G
- Elmex® - Gaba
- Elmex® Kinder-Zahnpasta (child) - Gaba
- Odol-med 3® - GlaxoSmithKline
- Odol-med 3® Milchzahn (child) - GSK
- PEARLS & DENTS® - Dr. Liebe

## Definitions

Measurement parameters used were the roughness average  $R_a$  (DIN 4768/1) and the maximum roughness depth  $R_{max}$  (DIN 4768/1).

The roughness average is a predication about the smoothness of a surface after substance abrasion.

The maximum roughness depth is a predication about the traces of scratch marks. Measurements take place from the untreated, smooth surface as a reference, through to the brushed surface into the untreated area again. The red area in figure 3 (Fig.3) points out the measured loss of surface substance.

In order to achieve a statistically relevant result, each product was tested 15 times. Therefore the table data show the mean value, the statistical median value and the standard deviation.

After 5 hours of suspension in water, the untreated acrylic glass plate produced an  $R_a$  value of 0.01  $\mu\text{m}$  and an  $R_{max}$  value of 0,15  $\mu\text{m}$ . False test results through possible modification of the roughness and maceration of the PMMA test plates due to water suspension may therefore be neglected in this study.

## Results

### $R_{max}$ (Fig. 4)

The maximum roughness depth of the reference paste produced a mean value of 84  $\mu\text{m}$ , Elmex® (84,8  $\mu\text{m}$ ) (Fig. 7) produced a similar result. Blend-a-med mediclean (76,2  $\mu\text{m}$ ) (Fig. 6), Blend-i® (71  $\mu\text{m}$ ) (Fig. 5) and Elmex® Kinder-Zahnpasta (75,9  $\mu\text{m}$ ) (Fig. 8) exhibit highly abrasive values. Odol-med 3® (43,4  $\mu\text{m}$ ) (Fig. 9), Odol-med 3® Milchzahn (24,8  $\mu\text{m}$ ) (Fig. 10) and PEARLS & DENTS® (7,6  $\mu\text{m}$ ) (Fig. 11) stand out clearly as notably less abrasive.

### $R_a$ (Fig. 12)

The roughness average of the reference paste produced a mean value of 17,4  $\mu\text{m}$ . A similarly high roughness average is seen in the products Elmex® (15,7  $\mu\text{m}$ ) (Fig. 15) and Blend-a-med mediclean (15  $\mu\text{m}$ ) (Fig. 14) Blend-i® (12,9  $\mu\text{m}$ ) (Fig. 13) and Elmex Kinder® (12,3  $\mu\text{m}$ ) (Fig. 16) clearly show lower values. The roughness average of Odol-med 3® (7,6  $\mu\text{m}$ ) (Fig. 17), Odol-med 3® Milchzahn (2,9  $\mu\text{m}$ ) (Fig. 18) and PEARLS & DENTS® (0,3  $\mu\text{m}$ ) (Fig. 19) clearly indicates a low median roughness.

## Discussion

Considering the fact that the average age of population is increasing, the lifetime of teeth should be increased simultane-

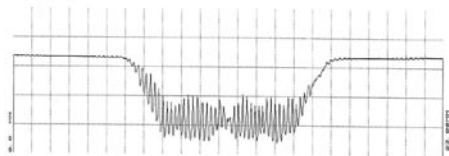


Figure 5: Rmax / Blendi®

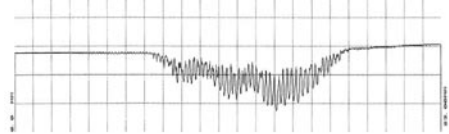


Figure 6: Rmax / Blend-a-med mediclean®

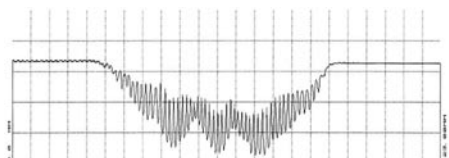


Figure 7: Rmax / Elmex®

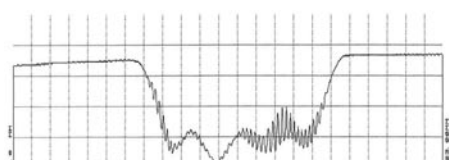


Figure 8: Rmax / Elmex® Kinder-Zahnpasta

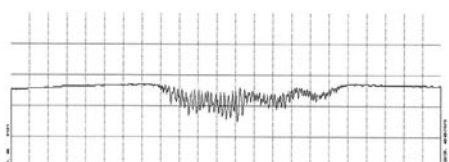


Figure 9: Rmax / Odol-med 3®

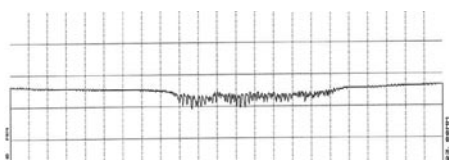


Figure 10: Rmax / Odol-med 3® Milchzahn

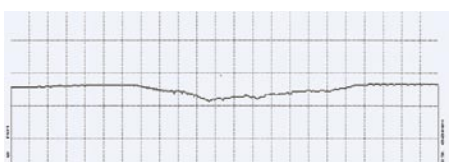


Figure 11: Rmax / PEARLS & DENTS®

ously. Toothpastes play an undeniable role in the preservation of healthy and intact teeth. With certain limitations, the roughness depths recorded during the experiment can be translated into the condition of human teeth; the brushing method used during the experiment is

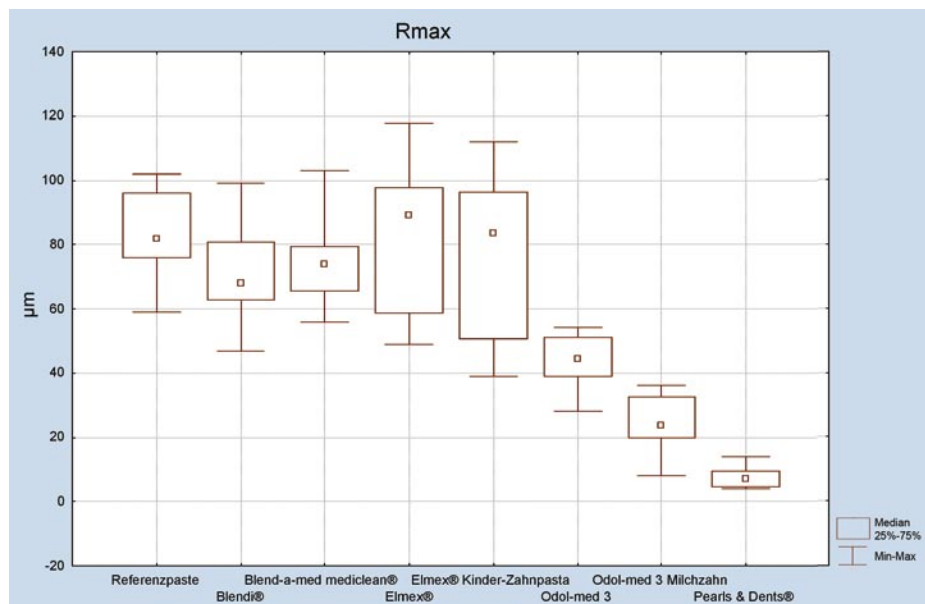


Figure 4: Boxplot Rmax Results

equivalent to the most common techniques used by people and furthermore it has been recorded that with age, more people present wedge-shaped defects.

The deeper the roughness depth in the enamel or dentine surface after brushing, the easier it is for bacteria to settle inside these creases. The tongue in combination with saliva is unfortunately not effective enough in cleaning these gaps. Therefore, a patient should opt for toothpaste, which produces a low roughness depth.

The roughness average, used as a measure to describe the surface qualities after brushing, should be considerably low. The smoother the surface after cleansing, the more difficult it is for bacteria to re-adhere to the surface (principle of surface area reduction).

The slight difference in the roughness average results of Elmex® and Elmex® Kinder-Toothpaste points to the fact that the producer, Gaba, sees the main criteria for differentiation between children and adults in the fluoride content (500/1250 ppm) and not in the abrasiveness of the toothpaste. Similarly abrasive toothpastes such as Blend-a-med mediclean® and Blendi® (P&G) are differentiating children's and adult toothpaste

mainly by flavour and fluoride content. Merely Odol-med 3® and Odol-med 3® Milchzahn show a significant difference in its abrasiveness between children's and adult's toothpastes. The manufacturer of Odol-med 3® Milchzahn (GSK) has purposefully decreased the abrasiveness in its children's toothpaste (RDA50), even though Odol-med 3®, the toothpaste intended for adults, already presents a lower abrasiveness than the previously mentioned toothpastes for children.

PEARLS & DENTS® (RDA 45) can claim an exceptional position. Due to its high fluoride content it is not suitable for children below the age of 6 years and there is currently no pendant for children on the market. The manufacturer recommends PEARLS & DENTS particularly for people undergoing orthodontic treatment, people with narrow inter-dental spaces, smokers, tea, coffee and red wine lovers. This fact would presume a high value of abrasiveness, since other toothpastes on the market for the same user group contain a generally much higher concentration of abrasive agents.

PEARLS & DENTS® uses EVA copolymer pellets to reduce the abrasiveness caused by commonly used cleansing agents. This technique has proven to produce effective

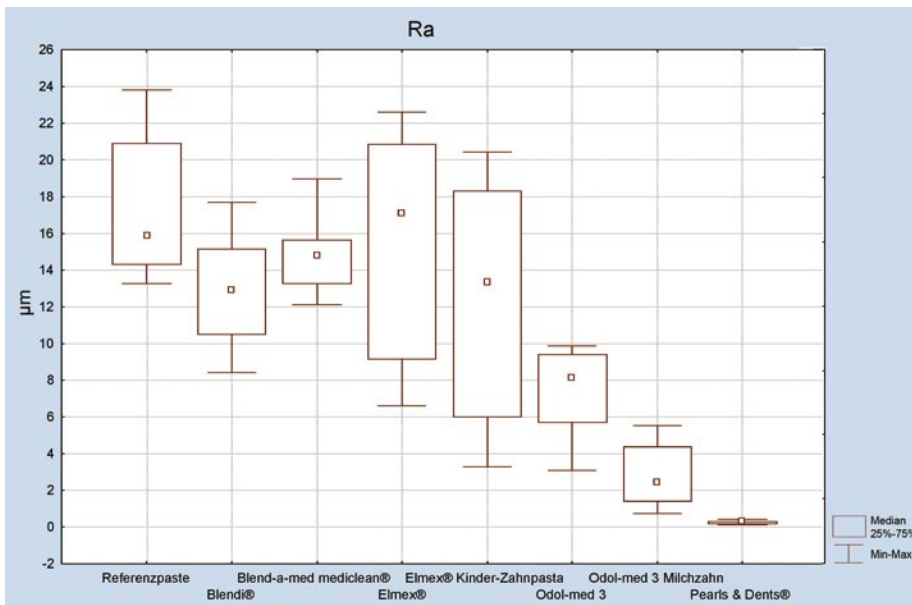


Figure 12: Boxplot Ra Results

tive cleansing results with low abrasion. Dyer et al. [6] were able to prove, that also the filaments (hard / soft) have an influence on the abrasion. Soft bristles rest more efficiently against the tooth and through the larger area of contact as well as the increased submission of toothpaste through dense bristles, they create a stronger abrasion on dentine and enamel. A critical point therefore is the contact between filament-toothpaste-tooth. The low abrasiveness of PEARLS & DENTS® could under these circumstances be explained through the industrially known roller-burnish-effect, where the main contact during the cleansing process does not take place between filament and surface, but between pellet and surface and respectively between filament and pellet.

Even if we take into account that the actual cleansing environment is different from an in-vitro environment, it should raise thought that Savil et al were able to determine, that a toothpaste with an RDA value of 75 can cause dentine abrasion of up to 51  $\mu\text{m}$  when used twice a day for a period of 3 weeks. This is possibly why Gaba recommends not to use Elmex® (RDA 77) twice a day but instead to switch to Aronal® once per day.

Apart from these considerations, the clear objective to achieve a gentle cleansing

effect, should remain the overall cleansing capabilities of toothpastes. Therefore it is of greatest importance to find an optimized cleansing formula that can provide an effective cleansing result whilst still being gentle on teeth.

## Summary

For the verification of abrasion of different kinds of toothpastes, abrasion tests were carried out on PMMA plates, which were evaluated with the help of a profile meter. The results show significant differences in the abrasiveness of the different products. For children, merely Odol-med 3® Milchzahn presents a reduced abrasive value. Elmex® Kinder-Zahnpasta and Blendi® are similarly abrasive to its adult counterparts. With a roughness average (Ra) value of only 0,3  $\mu\text{m}$  PEARLS & DENTS® presents the least abrasive qualities among all other products tested, including the products for children.

### Correspondence

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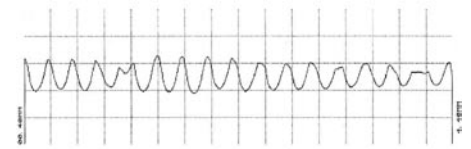


Figure 13: Ra / Blendi®

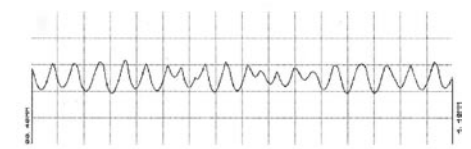


Figure 14: Ra / Blend-a-med mediclean®

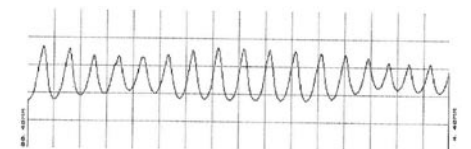


Figure 15: Ra / Elmex®

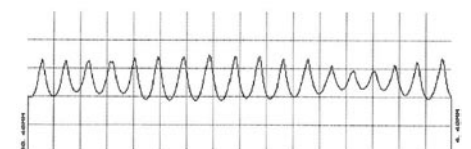


Figure 16: Ra / Elmex® Kinder-Zahnpasta

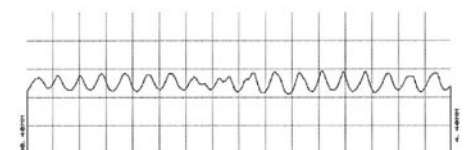


Figure 17: Ra / Odol-med 3®

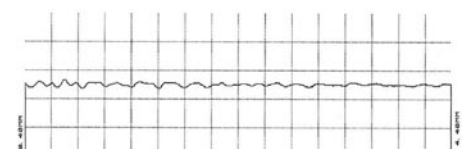


Figure 18: Ra / Odol-med 3® Milchzahn



Figure 19: Ra / PEARLS & DENTS®

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## Dr. Liebe, Germany

### The Specialist for Healthy Teeth

As a family business Dr. Liebe fully focuses on the production of high-grade toothpastes. We use -as far as possible- natural ingredients and insist on the highest quality standards. We do hope that PEARLS & DENTS will help you to keep your teeth healthy forever.

### Deeply Rooted and Firm Hold

Dr. Liebe has never ceased to follow the spirit of the company's founder. Social commitment and a grown corporate culture of family atmosphere and high motivation guarantee that all our staff care for our products and their quality. Many have been working for the company for years or even decades.

### A Short Version of a Long History

In 1895, the pharmacist Willibald Liebe makes his dream come true of running his own pharmaceuticals business. His son, Dr. Rudolf Liebe, follows in his footsteps after World War I. But in 1948, his life's work is expropriated. Hence, the Liebe family moves to Stuttgart and re-establishes the company there in 1950. Since 1962, Dr. Liebe is headquartered in Leinfelden-Echterdingen.

## Prof. Dr. Franz Günter Sander Curriculum Vitae

Prof. Dr. Franz Günter Sander was born 24. April 1943 in Gelsenkirchen, Germa-

ny. He commenced a physics university degree in 1965 and additionally began to study dentistry in 1968, obtaining both university degrees within 12 months: physics in 1972, dentistry in 1973. In the same year, he was awarded his doctorate (PHD) in dentistry and shortly after promoted to Dr. med. dent. at the University of Bonn in 1974.

From 1973 until 1977 he was trained as a specialist for orthodontics at the department of orthodontics at the University of Bonn, obtaining his specialist status as orthodontist in 1977. In 1978 he became the head of dental radiology and assistant orthodontist at the University of Bonn. In 1979 he began his state doctorate and after only two years was rewarded the professor title. Since 1981, Prof. Dr. Franz Günter Sander has been the head of the department for dentistry and orthodon-



tics at the University of Ulm, Germany. Over the past 25 years, Prof. Dr. Franz Günter Sander has published numerous scientific research papers and articles in industry journals. His long-term clinical research on biomechanical aspects

of multi-band appliances in regards to the usage of super-elastic materials has gained him worldwide recognition. He has been continuously engaged in the innovation of groundbreaking technologies on the orthodontic sector.

In co-operation with leading orthodontic technology suppliers, Prof. Dr. F-G. Sander has developed a number of innovative products; e.g. Derotation Springs, Molar Correction Springs, Memory Maker 3rd Generation, Trans Palatal Arch Bars with FORESTADENT, elastic vestibular screen with DENTAURIUM and PEARLS & DENTS with Dr. Liebe. He was also asked to lead the Official Scanning Performance Test of the KONICA MINOLTA VI-910 – a 3D reconstruction of a human mandible.

Further he has been a prominent speaker at orthodontic congresses or partner universities and has established a broad range of popular vocational training courses for orthodontists at the Collegium Frankfurt for Applied Orthodontics, Germany. Topics include: Straight-Wire-Technics 1 + 2, Biomechanical Aspects of Multiband Appliances – Advantages of Super-Elastic Materials, AKTIVE-RESPONSE© - Splint System, Multiband-Technics 1 – Intra- and Extraoral Anchor Elements, Multiband-Technics 2 – Canine Subsumption, Orthodontic Diagnostic with Teleradio-

gram Analysis, Established and latest Technologies in Functional Orthodontia. He is on the Advisory Editorial Board of the Journal of Orofacial Orthopedics – The Official Journal of the German Orthodontic Society.

## PEARLS & DENTS Composition and Effects

INCI-Name	Effects of Ingredients
<b>Amine Fluoride (Olaflur)</b>	Fluoride-formula: highly effective against caries formation; hardens the enamel
<b>Sodium Fluoride</b>	delivers instantly bio-absorbable Fluoride
<b>Xylitol</b>	prevents the formation of cariogenic bacteria and remarkably decelerates the process of tartar formation
<b>Ethylen-Vinylacetat Copolymer</b>	soft polymer pellets for a gentle, yet intensive cleansing process
<b>Bisabolol</b>	anti-inflammatory active ingredient extracted from Chamomile
<b>Chamomilla recutita Alcohol denat.</b>	anti-inflammatory; soothes the effects of sore gums and irritation of oral mucosa
<b>Panthenol</b>	anti-inflammatory natural ingredient; soothes the gums and oral mucosa
<b>Cocamidopropyl Betaine</b>	gentle foaming agent; enhances the equal distribution of active ingredients and intensifies the cleansing effect of the soft polymer pellets
<b>Glycerin Aqua Propylene Glycol</b>	keep the toothpastes moist and smooth
<b>Sodium Metaphosphate Silica</b>	cleansing compound for a gentle, yet intensive cleansing effect and prevention of plaque build-up and tartar-formation
<b>Hydroxyethylcellulose</b>	thickening agent of pharmaceutical quality
<b>Titanium Dioxide</b>	white pigment of food quality
<b>Sodium Benzoate</b>	preservative of food quality
<b>Saccharin</b>	sweetening agent for flavour enhancement
<b>Aroma</b>	aroma recipe of food quality
<b>Menthol Eucalyptol Anethol Eugenol Citronellol</b>	premium essential oils; combination specifically composed for therapeutic dental hygiene

RDA-Value 45  
Amine Fluoride (800 ppmF), Sodium Fluoride (400 ppmF)



## **PEARLS & DENTS - The Innovation in Dental Hygiene**

*PEARLS & DENTS is a truly innovative, high-end medical toothpaste developed and clinically proven by one of the leading German professors for orthodontics, Chairman Prof. Dr. Franz G. Sander of the University of Ulm, and manufactured in Germany since 1997 by the well-established and traditional manufacturer of medical toothpastes, Dr. Liebe.*

*PEARLS & DENTS combines a unique mechanical cleansing method with all the long-term proven benefits of high-end medical toothpaste. Its world-patented "Pearl-Cleansing-System" is highly effective against plaque and stains, but incomparably gentle on enamel and gums.*

*PEARLS & DENTS contains differently sized, essential oil-soaked polymer pellets, which are agitated by the brush and thus thoroughly clean and polish even in narrow interdental spaces and in otherwise hard-to-reach areas: below the gum line, in gingival pockets and at brace edges of fixed orthodontic appliances. The pellets also gently massage the gums, leaving them healthy and strong.*

*PEARLS & DENTS is free of bleaching agents or any other aggressive whitening and sanding agents. It is therefore substantially less abrasive than most common toothpastes, but still reaches a remarkable whitening effect. Through complete plaque and stain removal and gentle polishing, the enamel retains its youthful white and natural smoothness.*

*By restoring the dental surface, PEARLS & DENTS significantly reduces harmful effects of cariogenic bacteria on the enamel and dentine and successfully prevents the re-formation of deposits and stains – a truly tangible improvement.*

**PEARLS & DENTS**  
Innovative Medical Toothpaste with Pearl System

