The influence of surface free energy and surface roughness on early plaque formation

An in vivo study in man

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Abstract. Previous in vivo studies suggested that a high substratum surface free energy (s.f.e.) and an increased surface roughness facilitate the supragingival plaque accumulation. It is the aim of this clinical trial to explore the "relative" effect of a combination of these surface characteristics on plaque growth. 2 strips, one made of fluorethylenepropylene (FEP) and the other made of cellulose acetate (CA) (polymers with surface free energies of 20 and 58 erg/cm^2, respectively) were stuck to the labial surface of the central incisors of 16 volunteers. Half the surface of each strip was smooth (Ra $\pm$ 0.1 μm) and the other half was rough (Ra $\pm$ 2.2 μm). The undisturbed plaque formation on these strips was followed over a period of 6 days. The plaque extension at day 3 and 6 was scored planimetrically from color slides. Finally, of 6 subjects samples were taken from the strips as well as from a neighbouring smooth tooth surface (s.f.e. 88 erg/cm^2; Ra $\pm$ 0.14 μm). These samples were analysed with a light microscope to score the proportion of coccoid cells, and small, medium, and large rods or fusiform bacteria. At day 3, a significant difference in plaque accumulation was only obtained when a rough surface was compared with a smooth surface. However, at day 6, significantly less plaque was recorded on FEP smooth (19.4%) when compared with CA smooth (39.5%). Between FEP rough (96.8%) and CA rough (98.2%), no significant difference appeared. The latter were of course significantly higher than the scores of the smooth surfaces. Small differences in bacterial composition appeared: the highest % of coccoid cells was observed on FEP smooth (86.2%) and the lowest % on FEP rough (78.5%) and CA rough (82.8%). The results of this study suggested that the influence of the surface roughness on plaque accumulation and plaque composition is more prominent than the influence of the surface free energy.

Key words: bacteria; oral microflora; bacterial adhesion; surface properties; surface free energy; surface roughness; dental plaque.

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There is general agreement that the primary cause of gingivitis, periodontitis and caries is bacterial activity (Löe et al. 1965, Loesche et al. 1985, Newbrun 1983). Although these infections are explained by specific plaque theories, to date, the removal of all microbial deposits from the tooth remains essential in the prevention of these infections (Axelsson & Lindhe 1981). However, the bacterial recolonisation of a cleaned tooth surface occurs rapidly (Brecx et al. 1983, Berthold 1979, Quirynen & Van Steenberghe 1989). This explains the increased interest in factors which could interfere with normal bacterial adhesion.

Previous studies suggested an association between the substratum surface free energy and bacterial adhesion not only in vitro (Uyen et al. 1985, Busscher et al. 1986a) but also in vivo (Weerkamp et al. 1989, Quirynen et al. 1989). Other studies (Mierau 1984, Quirynen 1986, El-Abiad 1986) proved a positive correlation between the plaque growth rate and the roughness of the tooth surface.

The purpose of this clinical study was to explore the "relative" effect of the surface free energy and the surface roughness (separated and in combination) on early plaque formation and its composition.

Material and Methods

Experimental design

This clinical trial was designed as a split-mouth, double-blind study in which the plaque formation was followed longitudinally on 2 materials: fluorethylene-propylene (FEP) and cellulose acetate (CA) with a low and intermediate surface free energy (s.f.e.), respectively. From these materials, strips were made which were stuck on the labial surface of natural teeth. Moreover, the strips were divided transversely into 2 halves; the first half remained smooth and the other half was roughened by sandblasting with quartz particles of 250 nm for 15 to 30 s.

14 days prior to the experiment, all participants received professional tooth cleaning and were instructed to perform optimal oral hygiene to produce a high standard of gingival health, namely a mean sulcus bleeding index (Mühlemann & Son 1971) less than 0.3.

Prior to the clinical trial, all teeth were cleaned by means of a toothbrush and toothpicks. Plaque removal was carefully controlled by the use of a 0.5% aqueous neutral red solution (Merck, Darmstadt, West Germany), which is known to have no antibacterial effect (Morganstein & Ribbons 1969). Remaining plaque was removed with hand instruments. This procedure was repeated until complete plaque removal was achieved. Subsequently, the labial surfaces of the upper front teeth were polished for 30 s with a paste made of water and pumice. Any remaining polishing paste was removed by excessive rinsing.

The labial surfaces of the upper central incisors were provided with a strip, one tooth receiving FEP and the other CA. The location of each material was changed randomly within the subjects. These strips were stuck to the tooth surface by means of a cyanoacrylate glue (Histoacryl, B. Braun, Melsungen AG, West Germany). The lips were kept away with spring retractors, and the examiner wore gloves to avoid any contamination of the strips during placement. Strips (2–3 mm by 4–6 mm) were centered and placed ± 0.5 mm subgingivally. To ease the subgingival installation of the strips, the gingival pockets were widened slightly by means of dental floss.

Since one half of each strip was roughened too, this procedure enabled a comparison of 4 different surfaces within the same subject and in the same conditions: a surface with low s.f.e. and smooth (FEP smooth); a surface with higher s.f.e. and smooth (CA smooth); a surface with low s.f.e. and rough (FEP rough) and; a surface with higher s.f.e. and rough (CA rough).

During a 6-day period, the subjects had to refrain from any oral hygiene procedure and the undisturbed plaque accumulation was followed on the above-mentioned surfaces. The presence of plaque was recorded at zero time and after 3, and 6 days. At each visit, reproducible color slides were made after plaque disclosure with 0.5% neutral red. The area of plaque was calculated planimetrically from these color slides. To increase the reproducibility of this procedure, the precautions stated in a previous study (Quirynen et al. 1985) were followed strictly.

Subjects

16 healthy dental students participated in the study. None of the participants used mouthrinses, or had taken antibiotics in the year preceding the experiment. During the study, none of them wore any orthodontic or prosthetic device. There were no signs of periodontal breakdown or mouth-breathing.

Moreover, the selected teeth fulfilled the following criteria: no carious lesions or restorations, no enamel defects, no crowding of the teeth, a normally shaped dental arch, and very smooth surfaces. 4 of the 16 subjects lost 1 or 2 strips. They were withdrawn from the study.

Calculation of s.f.e.

For the examination of the s.f.e. of the investigated materials, contact angles were measured in vitro with water, water/n-propanol mixtures, and α-bromonaphthalene employing the sessile drop method (de Jong et al. 1982). Subsequently, s.f.e. were calculated by least-square fitting of the measured contact angle data to the geometric mean equation, with spreading pressures taken into account (Busscher et al. 1986b). For FEP and CA, the s.f.e. were 20 and 58 erg/cm^2, respectively. The s.f.e. of ground and polished human enamel is 88 erg/cm^2 (Van Pelt et al. 1983).

Measurement of the surface roughness

For the examination of the surface roughness pattern, a Perthometer C5D (Perthen, West Germany) was used. As illustrated in Table 1, comparable roughness values were observed for smooth and rough surfaces of both materials. The scores of the smooth surfaces are comparable with those of smooth natural teeth (Ra ± 0.14 μm, Kemp 1988).

Planimetrical plaque area analysis

After enlargement of the color slides up to 25$\times$ natural size, drawings were made of the outline of the strip, the border between rough and smooth site, the gingival margin, and the area covered with plaque. Since the plaque growth at the edge of the strip could be influenced by the presence of remaining glue or by a rough border between tooth surface and strip, only the central parts of the strips were used. Therefore, for each strip, a rectangular region with the same dimension was selected for the plaque examination. Special attention was paid to the fact that this region was kept at a minimal distance of 1 mm from each margin, and that its location was identical for the 4 surfaces. The presence of plaque was calculated by means of a planimeter (HAFF 15, GMBH Pfronten, West Germany) as a % of the total selected area in a double-blind set-up. Based on the red dye intensity, a difference was made between areas with thich plaque (red) and with thin plaque (pinkish red).

Table 1. The surface roughness examination on the four investigated surfaces

Substrata	Rz (μm)	Rmax (μm)	Rp (μm)	Ra (μm)	*n*
FEP smooth	0.75 $\pm$ 0.03	1.21 $\pm$ 0.04	0.57 $\pm$ 0.00	0.09 $\pm$ 0.00	3
CA smooth	0.70 $\pm$ 0.01	0.73 $\pm$ 0.02	0.39 $\pm$ 0.02	0.12 $\pm$ 0.00	3
FEP rough	15.20 $\pm$ 2.50	16.90 $\pm$ 0.60	8.80 $\pm$ 1.70	2.31 $\pm$ 0.26	4
CA rough	12.70 $\pm$ 0.90	15.00 $\pm$ 1.20	7.20 $\pm$ 0.90	2.01 $\pm$ 0.09	4

$\pm$ denotes S.D.

Rz = average depth, Rmax = deepest depth, Rp = vertical distance between highest point and centre line, Ra = average absolute distance from centre line, *n* = number of samples (per sample 5 observations).

Microscopical plaque analysis

At day 6, samples were taken from the strips of 6 subjects. These samples were carefully spread on a microscope slide with a periodontal probe in a drop of sterile water. Afterwards, a gram staining was performed.

From each half of a strip, 2 samples were taken, 1 from the cervical part and 1 from the incisal part. Moreover, from a neighbouring smooth tooth surface, 2 samples of a 6-day old plaque were taken at comparable locations. These samples served as control. Thus per subject, a total of 10 samples was analysed.

In a light microscope (Laborlux, Leitz, Wetzlar, West Germany) at magnification ×1200, the proportions of coccoid cells, and small, medium and large rods or fusiform bacteria were calculated. Per microscope slide, 3 regions, randomly selected, were analysed and for each region around 100 organisms were recorded. This part of the study was also performed as a blind investigation, since the investigator did not know the origin of the sample.

Statistical analysis

To examine whether the surface property could influence the in vivo plaque accumulation, for each test day, an analysis of variance was performed with plaque growth as dependent variable, (plaque expressed as thick plaque or as the sum of thick and thin plaque), with the 4 different surfaces as treatment and with the person as block factor (Proc GLM procedure in S.A.S.). Moreover, the Duncan multiple range test was used to detect differences between the 4 surfaces.

Results

Plaque extension

The influence of the surface roughness and the surface free energy on the plaque accumulation is shown in Fig. 1.

After 3 days of undisturbed plaque formation (Table 2), comparable amounts of plaque (expressed in thick plaque or in the sum of thick and thin plaque) were found for the 2 smooth surfaces and also for the 2 rough surfaces. However, a comparison between rough and smooth sites always led to significant differences.

After 6 days, more significant differences appeared (Table 3). The least amount of plaque was recorded on FEP smooth. Significantly more plaque was found on CA smooth. For the rough surfaces, significantly higher scores were obtained. A difference between FEP rough and CA rough was only reached if the level of significance was increased up to 0.1 and only when thick plaque was taken into account.

The influence of the surface roughness on plaque formation is also illustrated by Fig. 2, indicating a thin section through the rough and smooth part of an FEP and a CA strip. In addition to an increased plaque area, an increased plaque height was also observed on the rough surfaces.

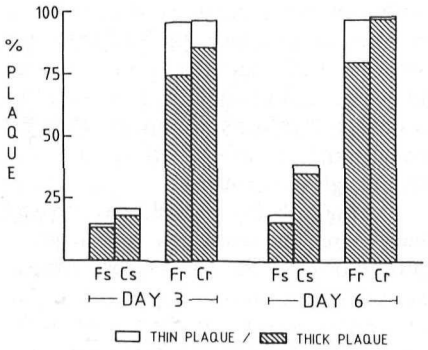

Fig. 1. Mean plaque scores ($n=12$) for the 4 different surfaces at days 3 and 6. A differentiation is made between thick and thin plaque. Fs = FEP smooth, Cs = CA smooth, Fr = FEP rough, Cr = CA rough.

Table 2. The influence of the surface free energy and the surface roughness on the plaque extension after 3 days

Thick plaque

The Duncan multiple range test

Surface	Mean plaque area	Duncan grouping
FEP smooth	13.750	A*
		A
CA smooth	18.625	A
FEP rough	75.158	B
		B
CA rough	85.842	B

Analysis of variance

Source	DF	Pr > F
person	11	0.0079
surface properties	3	0.0001

Total plaque

The Duncan multiple range test

Surface	Mean plaque area	Duncan grouping
FEP smooth	14.725	A*
		A
CA smooth	21.333	A
FEP rough	96.725	B
		B
CA rough	97.200	B

Analysis of variance

Source	DF	Pr > F
person	11	0.0044
surface properties	3	0.0001

* Means with the same letter are not significantly different at a level of significance $\alpha = 0.05$.

Indicated are: a Duncan multiple range test to detect differences in plaque accumulation on the 4 surfaces ($n=12$); an analysis of variance with the plaque score as dependent variable, with the 4 surfaces as surface properties and with person as block factor.

Table 3. The influence of the surface free energy and the surface roughness on the plaque extension after 6 days

Thick plaque

The Duncan multiple range test

Surface	Mean plaque area	Duncan grouping	
FEP smooth	16.200	A†	A*
CA smooth	35.775	B	B
FEP rough	79.525	C	C
		C	
CA rough	97.842	C	D

Analysis of variance

Source	DF	Pr > F
person	11	0.0086
surface properties	3	0.0001

Total plaque

The Duncan multiple range test

Surface	Mean plaque area	Duncan grouping	
FEP smooth	19.383	A†	A*
CA smooth	39.492	B	B
FEP rough	96.750	C	C
		C	C
CA rough	98.233	C	C

Analysis of variance

Source	DF	Pr > F
person	11	0.0091
surface properties	3	0.0001

† Means with the same letter are not significantly different at a level of significance $\alpha = 0.05$

* Means with the same letter are not significantly different at a level of significance $\alpha = 0.10$.

Indicated are: a Duncan multiple range test to detect differences in plaque accumulation on the 4 surfaces ($n=12$); an analysis of variance with the plaque score as dependent variable, with the 4 surfaces as surface properties and with person as block factor.

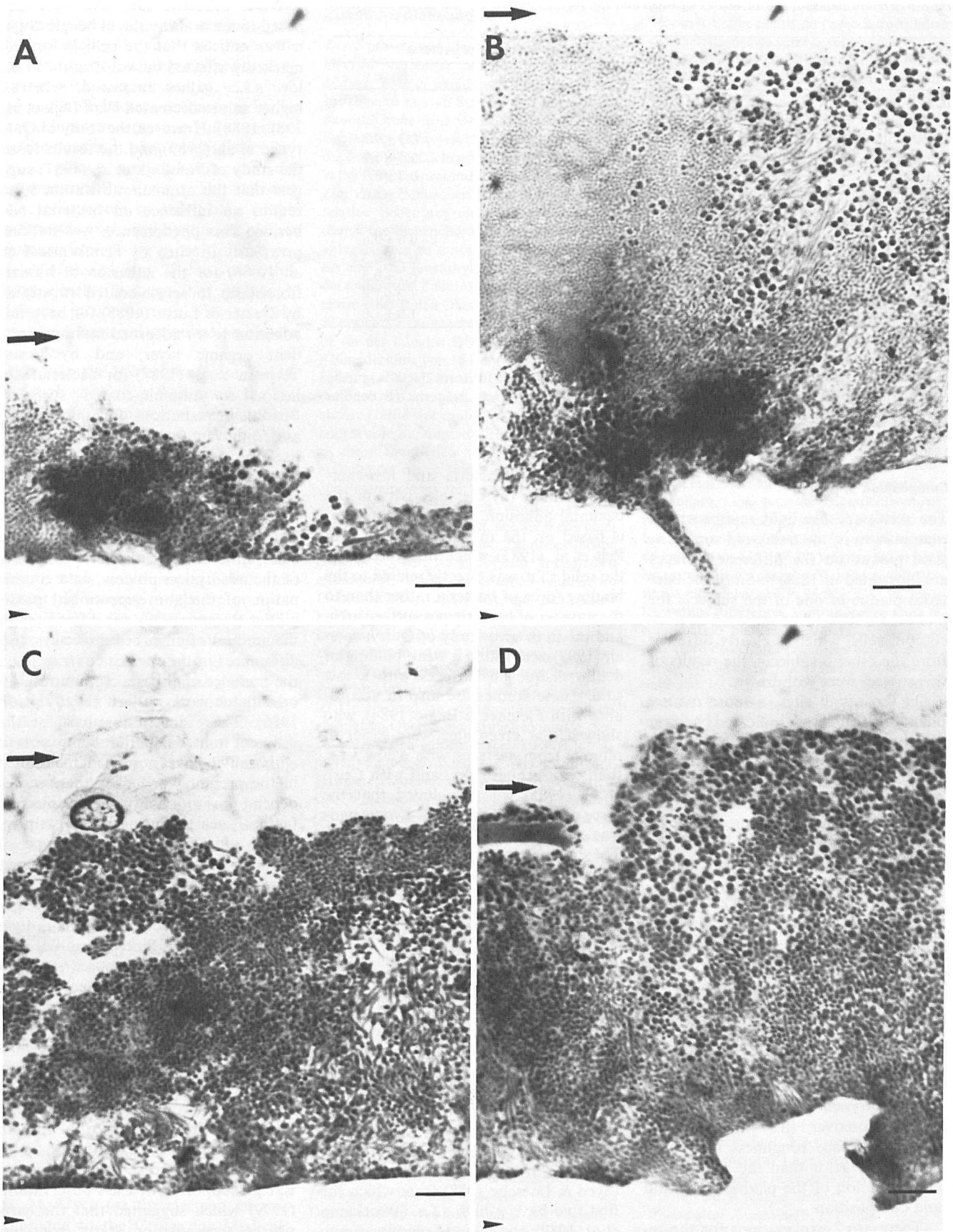

Fig. 2. Microscopical pictures from 2 μm thick sections (perpendicular to the long axis) through a FEP and a CA strip with a 6-day-old plaque. The speciments were dehydrated, fixated and embedded in Technovit 7100 (Kulzer, Friedrichsdorf, West Germany). Bar: 5 μm. A: FEP smooth, B: FEP rough, C: CA smooth, D: CA rough. ►= location of strip, →=embedding media.

Table 4. The influence of the surface roughness and the surface free energy on the composition of the plaque

Surface	% coccoid cells	"% rods and/or fusiform bacteria"		
		small	medium	large
Incisal half				
FEP smooth*				
CA smooth	88.3±10.7**	9.2±8.4	2.2±2.1	0.3±0.2
E smooth	90.6±5.3	6.8±4.8	2.1±0.7	0.5±0.9
FEP rough	82.9±13.1	12.1±9.4	4.3±4.9	0.7±0.9
CA rough	84.0±7.4	10.8±3.3	3.7±4.2	1.5±2.0
Cervical half				
FEP smooth	91.5±7.2	4.8±4.5	3.1±3.2	0.6±0.6
CA smooth	91.6±4.7	5.3±4.1	3.0±1.5	0.2±0.3
E smooth	91.0±5.3	6.7±4.3	1.7±1.1	0.7±0.5
FEP rough	86.7±7.7	7.4±4.3	4.7±3.1	1.2±1.4
CA rough	87.1±4.9	8.0±3.1	4.0±3.6	1.0±1.0

* Bacteria present in only 1 subject.
** Mean from 5 subjects and standard deviation.
Indicated are: the relative % of: coccoid cells, small rods or small fusiform bacteria, media rods or medium fusiform bacteria, and large rods or large fusiform bacteria. (E denotes enamel surface = control site).

Composition of plaque

The results of the light microscopical examination of the 6-day-old supragingival plaque on the different surfaces are illustrated in Table 4. Since the bacterial plaque of one of the subjects for more than 50% was composed of non-coccoid cells, which is clearly different from the other 5 subjects, the results of this subject were withdrawn.

On the rough sites, a more mature plaque was observed, indicated by fewer cocci and a higher proportion of rod-shaped bacteria. Minor differences were observed between the cervical and incisal parts of the strips. The differences between the materials with a comparable roughness or between incisal and cervical halves of the tooth were inconclusive.

Discussion

The results of this study prove a clear association between plaque accumulation on the one hand and both the substratum surface free energy and the substratum surface roughness on the other. This is in accordance with previous studies (Glantz 1969, Mierau 1984, Quirynen 1986, Quirynen et al. 1989). Moreover, this study suggests that the surface roughness is a more prominent factor than the s.f.e. in the determination of the plaque formation and composition.

There are 2 explanations for the reduced plaque formation on surfaces with a low s.f.e.: (i) the lower binding force between bacteria and low-energetic surface; (ii) the selectivity in the bacterial adhesion. The first statement is based on the in vitro study of Van Pelt et al. (1985) which illustrated that the solid s.f.e. was directly related to the binding force of bacteria rather than to the number of bacteria per surface area, and on an in vivo study of Quirynen et al. (1989) who found a weak binding of dental plaque on surfaces with a low s.f.e. These studies are also in accordance with Fletcher & Baier (1984), who showed that green alga were easier to remove from surfaces with a low s.f.e. than with a high s.f.e., and with Crisp et al. (1985) who concluded that the force of adhesion of mussel byssus pads was a function of the substrata s.f.e. The 2nd statement is based on the formula of Absolom et al. (1983), in which the interfacial free energy of adhesion was correlated with the solid-bacterium interfacial free energy, the solid-liquid interfacial free energy, and the bacterium-liquid interfacial free energy. Based on this formula, in vitro studies (Busscher et al. 1984, Uyen et al. 1985) showed that bacteria with a low s.f.e. adhered in the highest numbers to low-energy solids, whereas bacteria with a high s.f.e. adhered better to high-energy solids. Because 80% of the early bacterial plaque in man consists of the *Streptococcus sanguis, Veillonella parvula* and in lower concentration *S. mitis* (Syed & Loesche 1978) from which the first two have a high s.f.e. (Weerkamp et al. 1989), the reduced plaque growth on FEP in comparison to CA could be expected.

When different substrata were exposed to the oral cavities of beagle dogs, it was noticed that the pellicle formed markedly affected the substratum s.f.e.; low s.f.e. values increased, whereas higher values decreased (Van Dijk et al. 1987, 1988). However, the study of Quirynen et al. (1989) and the results from the study of Van Dijk et al. (1987) suggest that the original substratum s.f.e. retains an influence on bacterial adhesion. This phenomenon was noticed previously in vitro by Schakenraad et al. (1986) for the adhesion of human fibroblasts to serum-coated substrata; by Dexter & Lucas (1985) for bacterial adhesion to an adsorbed multi-component organic layer; and by Pratt-Terpstra et al. (1987) for bacterial adhesion to albumin-coated surfaces. Possible explanations for this finding are: (i) the fact that the adsorbed pellicle itself provides a mean of information transferral that could be due to differences in the molecular composition of the adsorbed protein layers, differences in the conformation of adsorbed molecules, differences in the time constants of the adsorption process, or a combination of the above-mentioned possibilities (Dexter 1979); (ii) differences in the amount of adsorbed molecules; (iii) differences in the surface coverage, i.e., the presence of either a continuous film or a patch-work pattern (Hlady et al. 1986). The exact s.f.e. values for the different materials after being coated with saliva have not been mentioned in the present work since these scores depend on too many methodological factors, such as rinsing before strip removal, duration of coating, type of coating, contamination with bacteria, degree of dehydration, etc.

The influence of the surface roughness on plaque accumulation is not yet well documented. Since the initial bacterial adhesion is supposed to pass through a phase with a "weak and reversible" binding before an irreversible binding is established (Carlsson 1983), it seems acceptable that this change occurs preferentially in the niches of surface irregularities where the micro-organisms are protected against mechanical shear, in contrast to a smooth surface where they constantly have to resist removal forces. This explanation is, e.g., supported by Lie's observations (1979) which suggested that the early plaque accumulation starts from pits and grooves from where the bacteria subsequently spread over the tooth sur-

face. A second explanation for the increased plaque growth on rough surfaces is simply the fact that due to the roughness, the available surface area increases with a factor $\times 2$ to $\times 3$ which can facilitate bacterial adhesion. In the dental literature, there is still a contradiction concerning the exact relation between plaque accumulation and the roughness of the surface. The fact that more plaque was recorded on a rough surface was explained by quicker plaque accumulation or by more difficult removal of this plaque. The results of this study clearly illustrate that on rough surfaces, in comparison with smooth, the rate of bacterial colonisation clearly increases.

Because the bacterial recolonisation on rough surfaces is facilitated, the establishment of a more mature plaque on such surfaces could occur more rapidly. This is a logical explanation for a lower % of coccoid cells on the rough surfaces. Although an in vivo microbiological study already demonstrated an influence of the s.f.e. on the bacterial adhesion (Weerkamp et al. 1989), the present study could not establish important differences in plaque composition. This is not surprising, since the previously observed changes were mainly within the streptococcal group and therefore not microscopically discernable. However, if the proportion of rods is taken as an indication of periodontopathic potential, it is important to note that the plaque on the FEP surface, which was clearly less voluminous in comparison with CA or Enamel (Quirynen et al. 1989), seems not more pathologic than the plaque on natural teeth. Moreover, in a previous study (Weerkamp et al. 1989), plaque on FEP did not contain an increased proportion of cariogenic bacteria.

In summary, it is concluded that a surface with a low s.f.e. and a low surface roughness clearly can delay plaque accumulation in vivo and that the influence of the surface roughness on plaque accumulation is more important than that of the surface free energy.

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Zusammenfassung

Der Einfluss freier Oberflächenenergie und der Oberflächenrauheit auf die frühe Plaquebildung. Eine in vivo Studie am Menschen

In früheren in vivo Studien wurde geäussert, dass die hohe freie Oberflächenenergie eines Substrates (s.f.e. = surface free energy) und die hohe Oberflächenrauheit, der supragingivalen Plaqueansammlung Vorschub leistet. Ziel dieses klinischen Versuches ist es, die relative Bedeutung einer Kombination solcher Oberflächencharakteristika für Plaqueanlagerungen zu untersuchen. Zwei Streifen, der eine aus Fluoräthylenpropylen (FEP) und der andere aus Zelluloseazetat (CA) (Polymere mit einer freien Oberflächenenergie 20 und 58 erg/cm^2, in angegebener Reihenfolge) wurde an der labialen Oberfläche der mittleren Schneidezähne von 16 freiwilligen Probanden befestigt. Die Hälfte der Oberfläche eines jeden Streifens war glatt (Ra $\pm$ 0.1 μm) und die andere Hälfte war rauh (Ra $\pm$ 2.2 μm). 6 Tage lang wurde die ungestörte Plaqueanlagerung an diese Teststreifen beobachtet. Auf Farbaufnahmen wurde sodann die Ausdehnung des Plaquebelages am 3. und 6. Versuchstage ausgemessen. Schliesslich wurden an den Streifen von 6 Probanden, wie auch von einer ihrer benachbarten, glatten Zahnoberflächen (s.f.e. 88 erg/cm^2; Ra $\pm$ 0.14 μm), Stichproben entnommen. Diese Stichproben wurden im Lichtmikroskop analysiert um den Anteil kokkoider Zellen und kleiner, mittlerer und grosser Stäbchen oder fusiformer Bakterien zu bestimmen. Am 3. Versuchstag lag hinsichtlich der Plaqueansammlung zwischen den Entnahmestellen nur dann ein signifikanter Unterschied vor, wenn eine rauhe mit einer glatten Oberfläche verglichen wurde. Am Tage 6 wurden jedoch an den FEP (Fluoräthylen)-glatten Streifen (19.4%) signifikant geringere Plaquemengen registriert als an den CA (Zelluloseazetat)-glatten Streifen (39.5%). Zwischen FEP rauh (96.8%) und CA rauh (98.2%) ergab sich kein signifikanter Unterschied. Die letztgenannten Werte lagen selbstverständlich signifikant höher als die Messergebnisse an den glatten Oberflächen. Hinsichtlich der Zusammensetzung der Bakterienflora lagen nur geringe Unterschiede vor. Der höchste prozentuale Anteil kokkoider Zellen wurde an FEP-glatten Streifen (86.2%) und der niedrigste an FEP-rauh (78.5%) und CA-rauh (82.8%) gemessen. Die Resultate dieser Studie legen nahe, dass die Rauhigkeit für Anlagerung und Zusammensetzung der Plaque von grösserer Bedeutung ist als die freie Oberflächenenergie.

Résumé

Influence de l'énergie libre et de la rugosité de surface sur la formation de la plaque dentaire. Une étude in vivo chez l'humain

Des études in vivo antérieures ont suggéré qu'une haute énergie libre de surface (s.f.e.) et une rugosité supérieure de surface facilitaient l'accumulation de plaque dentaire supra-gingivale. Le but de la présente étude a été de découvir l'effet relatif de l'association de ces caractéristiques de surface sur l'accumulation de plaque. Deux bandelettes, l'une de propylène de fluoréthyline (FEP) et l'autre d'acétate de cellulose (CA) – polymères ayant une énergie libre de surface de 20 et 58 erg/cm^2 respectivement – ont été collées au niveau de la surface vestibulaire des incisives centrales de 16 volontaires. La moitié de la surface de chaque bandelette était lisse (Ra $\pm$ 0.1 μm) tandis que l'autre était rugueuse (Ra $\pm$ 2.2 μm). La formation de la plaque dentaire sur ces bandelettes a été suivie pendant six jours. L'étendue de la plaque a été mesurée planimétriquement à partir de diapositives couleur aux jours 3 et 6. De plus, des échantillons provenant de six sujets ont été prélevés au niveau des bandelettes ainsi que de la surface lisse (s.f.e. 88 erg/cm^2; Ra $\pm$ 0.14 μm) d'une dent avoisinante. Ces échantillons ont été analysés à l'aide d'un microscope optique pour évaluer la proportion de cellules cocoïdes et de petits, moyens et grands bâtonnets et fusiformes. Au jour 3 une différence significative d'accumulation de plaque n'était trouvée qu'entre une surface rugueuse et une lisse. Cependant, au jour 6, significativement moins de plaque était visible au niveau des bandelettes lisses FEP (19.4%) qu'au niveau de celles lisses CA (39.5%). Entre les bandelettes rugueuses, aucune différence significative n'a été relevée (FEP: 96.8%; CA: 98.2%). De petites différences sont apparues dans le composition bactérienne: le pourcentage le plus élevé de cellules coccoïdes était observé sur les surfaces FEP lisses (86.2%) et le moins élevé sur les FEP (78.5%) et CA (82.8%) rugueuses. Les résultats de la présente étude suggèrent que l'influence de la rugosité de la surface est plus importante que celle de l'énergie libre de surface sur l'accumulation de la plaque dentaire supra-gingivale ainsi que sur sa composition.

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