The Vector Method

Clinical application and scientific principles

Periodontitis
Therapy and prophylaxis

Periimplantitis
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Dental hygiene

Microinvasive
cavity preparation

VECTOR

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The Vector Method:
A translation of the clinical application and scientific principles

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Important note

Dentistry as a science is subject to constant change. The results of research, observations from practice and clinical experience extend our knowledge; technical developments add to the number of options available to us in the diagnostics and therapy of disease.

In so far as a compendium such as this recommends methods of treatment, applications, instruments, drugs, doses, etc., the reader may rely on the fact that the author and publisher have made every effort to ensure that this information corresponds to the latest scientific knowledge at the date of publication.

Nevertheless, all users are asked to make their own decisions as regards therapy, on their own responsibility, taking account of all the requisite information, for instance, specialist publications or the information leaflets which accompany the various products, or medical contraindications, etc.

Attention is drawn to strict observance of the information laid down in the Medical Products and Drugs Laws. Users must be guided by the regulations issued by the national Authorities relevant in their particular case.

Contents

1 The Vector Method

General application information

The characteristic feature of the Vector system is a ring-shaped oscillating resonance body driven by an ultrasonic motor in a dental handpiece. The cyclical deformation of this ring arranged in the head of the handpiece induces a secondary vertical oscillation movement. An instrument attached at 90° offset to the handpiece longitudinal axis is therefore moved up and down linearly, passively driven by the ring.

Uncontrolled tumbling movements and mechanical vibrations from standard sonic and ultrasonic instruments and their self-oscillation characterized by oscillation loops and nodes as well as the resulting development of heat are therefore eliminated. High volumes of cooling water are not needed and the water supplied is not sprayed as an aerosol. The design of the Vector instruments is not subject to the usual restrictions (form and dimension, limited length or risk of breakage) and is exclusively oriented to the established clinical needs.

The strict linear movement of most of the instruments results in high tactile sensitivity for the operator. Together with the shape of the instruments, designed according to the criteria of minimal invasiveness, a high level of patient acceptance is achieved. Mechanical damage to the tooth and root surfaces or to sensitive restoration materials or implants are reliably avoided.
With curved instruments too, such as, for example, the curved periodontal probe with a slightly superimposed up and down movement of the instrument tip, disconnection of the instrument from the actual ultrasonic motor and the associated drastic reduction of the active oscillating mass result in a high error tolerance. In the event of forced handling or excessive contact pressure the high frequency digitally controlled oscillation drive switches off spontaneously for the duration of this incorrect application.

Fig. 1 - 1 *Vector system for initial periodontal treatment in situ. A determining factor in its functioning is the coating of fluid or suspension adhering around the instrument. Excess fluid may therefore not be removed directly from the site of treatment.*

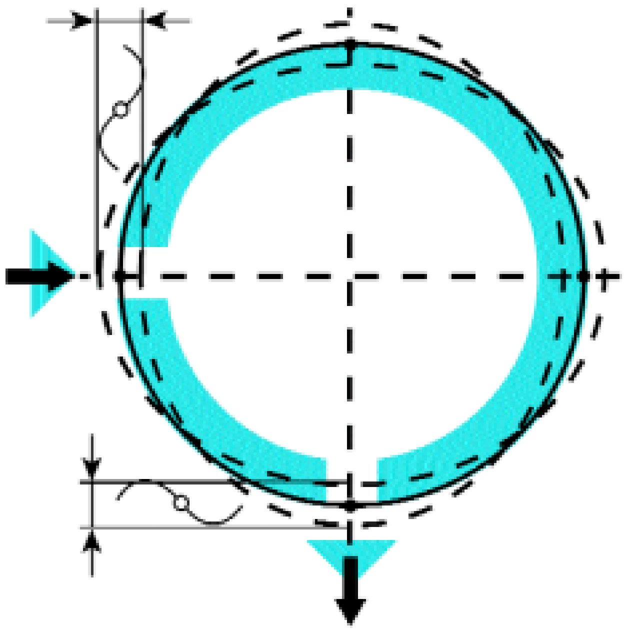


Fig. 1 - 2 *The deflection of the oscillation in the ring-shaped resonance body is typical of the Vector. If the ring is compressed in the horizontal by the ultrasonic motor, a downward movement in the vertical is enforced. The following horizontal expansion induces a vertical upwards movement.*

The fluid supplied to the Vector instruments serves for **indirect transmission** of the dynamic ultrasonic energy to the surfaces being treated. The functional principle is therefore similar to ultrasonic cleaning baths or lithotripter systems (e.g., for breaking up kidney stones). In medical ultrasonic diagnostics, too, the energy is applied via a watery gel.

Due to the longitudinal oscillations of the Vector instrument the wetting behaviour of the instrument surface for applied fluid is greatly improved. An adhering water droplet becomes a film of water surrounding the instrument, regardless of its position on the instrument. Through the high acceleration of the instruments driven linearly in the ultrasonic range, the water coating is bound firmly to the surface of the instrument. This means that even in small gingival pockets, narrow cavities or in deep root canal areas – regardless of gravitation (instrument position in the upper jaw) – an adequate film of liquid is always available. Circular impulses, which lead to a dispersion of very fine water drops forming an aerosol, are eliminated.

The whole instrument is subject to practically the same movement pattern on all surface sections. There are no nodal surfaces without a movement or zones of maximum acceleration (oscillation loops). This results in marked fluid (rinsing) dynamics around the whole instrument, which, in combination with the excess fluid applied by pulsation, ensures a high degree of cleaning efficiency. The additional option of adding dissolved active ingredients to the open fluid system extends the degree of therapeutic freedom.

Fig. 1 - 3 *Due to the linear movement of the instrument, the wetting behaviour of an active Vector instrument for supplied fluid is improved. An active Vector instrument is surrounded by a firmly adhering coating of fluid.*

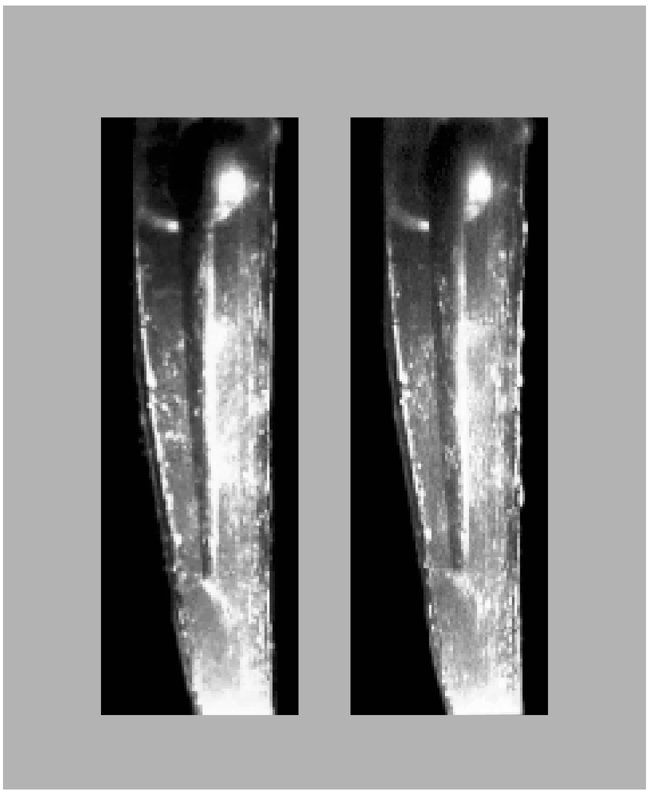


Fig. 1 - 4 *Hydrodynamic flow: staggered still video images of a Vector probe in a model periodontal pocket (left boundary surface: simulated soft tissue of the pocket; right boundary surface: simulated root surface, biofilm simulated by metal sputter layer). The loosened metal particles are seen on the image as light reflective points.*

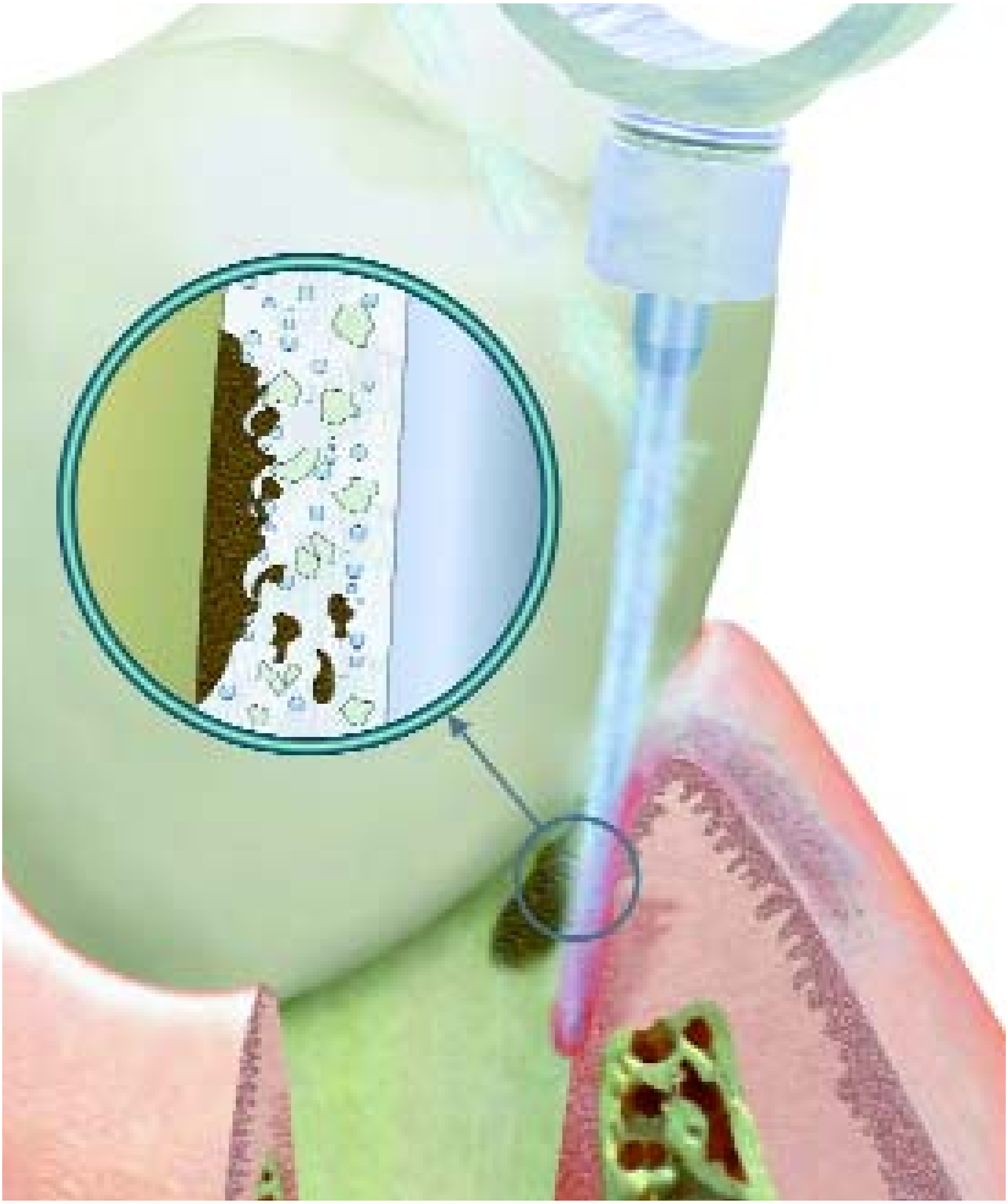


Fig. 1 - 5 *Energy contact during the Vector treatment is achieved indirectly via a water film adhering to the instrument. The dosing of energy is determined by varying the contact conditions (instruments material and use of particle suspensions).*

For traditional sonic and ultrasonic instruments, which mainly act on a mechanical operating principle, the dosing is achieved by presetting the vibration amplitude. This regulating variable is of secondary importance with the Vector system. Most applications are carried out at constant amplitude of about 30 μm (all green LEDs light up). The maximum amplitude of approximately 35 μm (kick-down function) is intended for the removal of solid hard calculus, for recontouring applications or during microinvasive preparations. **Control of energy transmission** is carried out by influencing the contact conditions. These can be effectively varied by the preselection of instrument materials and by the use of different suspensions. A high application of energy is achieved by using metal instruments with low attenuation characteristics and high abrasion resistance. Metal instruments are therefore suitable for the removal of hard calculus and for recontouring, finishing or microinvasive preparation of hard tooth tissue or non-metallic dental restorations.

Alternative instruments which are available made of flexible fibre composite materials, work in the Vector system with reduced energy application. Part of the instrument's energy is subject to attenuation effects on the flexible instrument surface. On the other hand the abrasion resistance of the instruments made out of a fibre reinforced composite is decreased in comparison to the Vector metal instruments. These instruments are particularly beneficial for gentle removal of subgingival biofilms and supragingival plaque or discolorations, with maximum protection for sensitive structures, such as root cementum, exposed dentine surfaces, initial caries, sensitive tooth, dental restoration or implant surfaces. The resultant high error tolerance simplifies the use of these instruments even for trained dental assistants. Hard calculus deposits or restoration overhangs can therefore only be removed with these instruments to a limited extent. The flexibility and design in accordance with minimally invasive criteria facilitate access and handling even in anatomically difficult areas. The use of fibre composite instruments is therefore especially recommended during supportive periodontal therapy for removing of staining as well as for the therapy and prophylaxis of periimplant mucositis or periimplantitis.

A straight probe made of an unfilled, highly flexible plastic is available for almost exclusive use of the fluid dynamic effects with insignificant energy contact to the surfaces being treated. It is mainly intended to be used as a rinsing instrument for example during the treatment of endodontic-periodontal lesion.

A further influence on the application of energy can be achieved by particle additives in the contact fluid. The medium is more or less abrasive, depending on its hardness or the shape and the size of the particles suspended in the fluid. By using the Vector Fluid Polish suspension with ultrafine hydroxyapatite (HA) particles added (average grain size approximately 10 μm), thorough removal of subgingival adhesive biofilms is achieved. The fine grains and the low surface hardness of the HA particles, whilst having a gentle polishing effect, prevent damage to or removal of the surface of the hard tooth tissue, implant or dental restoration. The natural root structures, which are important for periodontal regeneration, are therefore not endangered.

For abrasive indications, such as for cavity preparation according to minimally invasive criteria, the finishing of cavity margins or the recontouring or finishing of dental restorations, a suspension containing silicon carbide (SiC) (Vector Fluid abrasive) is used. The average grain size of the extremely hard, block-shaped cutting SiC particles is approximately 40 - 50 μm. In this case, too, there is an indirect application of energy, as is familiar in similar form from lapping or polishing methods. This results in a very gentle, almost non-thermal processing of hard tooth tissues and non-metallic restoration materials, with maximum care of the tissue and pulp and without marginal fractures. Metal alloys (with the exception of slight contour overhangs, e.g. of amalgam fillings) or soft dentine caries, on the other hand, can be prepared only to a very limited extent.

2 Periodontal aspects of the Vector system

2.1 Pathogenesis of periodontitis

Gingivitis and periodontitis are caused and sustained by the products of mixed bacterial flora (Kahnberg et al. 1976). Some substances in the subgingival, microbial biofilm, such as virulent enzymes or lipopolysaccharides (LPS) of gram-negative bacteria, may cause direct harm to host cells and tissue. However, the periodontal tissue can be attacked in particular by inflammatory mechanisms and by cellular and humoral immunoprocedures activated by the microorganisms in the sulcus and biofilm or their products. This inflammatory response in the affected periodontium is mostly clinically visible (reddening, swelling, bleeding on probing, suppuration, etc.).

The patient suffering from periodontitis does not generally show homogeneous findings. The severity of the periodontitis varies between individuals and in the same individual from tooth to tooth, and not unusually, from tooth surface to tooth surface. Each site is to be regarded as an individual, specific niche.

At some sites the inflammatory lesion may be restricted for a long time to the gingiva and is reversible. At other sites the inflammation may penetrate the deeper layers of tissue, causing irreversible damage to the surrounding host cells, connective tissue structures and alveolar bone. Cells of the gingiva and the sulcular epithelium may come into contact with metabolites, enzymes and surface substances (LPS) of bacteria due to microbial plaque accumulation. The irritation of the host cells increases as the mass of vital bacteria grows. Bacterial substances cause the epithelial cells continually to produce an increasing number of chemical mediators (e.g. cytokines). In an attempt to maintain epithelial integrity, these mediators force an inflammatory reaction with all the classic symptoms. Cascade-like reactions of the immunodefence system result in the formation of proteinases which lead to the destruction of gingival and periodontal connective tissue structures. Induced prostaglandins are significant mediators for the destruction of periodontal bone.

Fig. 2 - 1 *Microbially induced inflammation and immune reactions characterize gingivitis and periodontitis; they cause invasion and spread of microorganisms into the deeper tissues.*

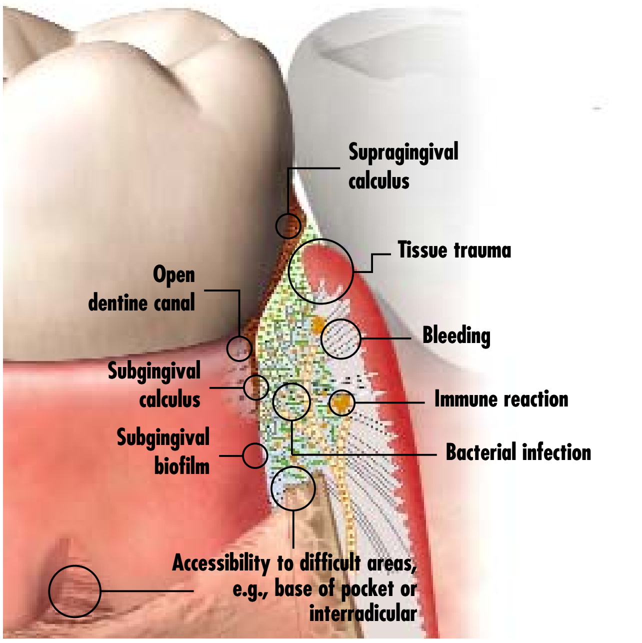


Fig. 2 - 2
Problems of causally orientated periodontal therapy.

Whilst gingival inflammation is very probably caused by the quantity of plaque, and in many cases by hormonal processes (Löe et al., 1965), current literature dealing with the pathogenesis of periodontitis still leaves many questions open. It is possible that an hereditary immunodeficiency due to defective inflammatory, immunological or regenerative reactions is also involved. Susceptibility to periodontitis possibly relates to the ability or inability to build sufficient effective antibodies against the specific causative bacteria. Occlusal trauma is not sufficient to destroy the periodontal tissue. However, if teeth with plaque-associated periodontitis are affected by centric prematurity or functional overload, these may be cofactors in accelerating the progression of the disease.

2.2 Periodontitis and systemic diseases

Recent scientific evidence has increasingly indicated that periodontal disease may increase the risk of systemic diseases, such as coronary heart disease, heart attacks, strokes, arteriosclerosis, but also the risk of premature births (Page, 1998). The extensive inflammatory lesions of generalized marginal periodontitis (analogous to the size of a hand surface), the large, constantly renewing reservoirs of bacteria and the high stability of the biofilms are major causes for the systemic effects of periodontal disease. Lipopolysaccharides, vital gram-negative bacteria or inflammatory cytokines can continually penetrate the blood circulation from the inflamed periodontal tissues in pathobiologically significant volumes, and may mediate the effect of disease in other areas of the body. On the other hand, the same risk factors contribute to periodontitis and to various systemic diseases, in particular smoking, stress and increasing age.

2.3 Differential diagnosis of marginal periodontitis

In many cases it is difficult to differentiate between an endodontic lesion, which often concerns the apical periodontium and is caused and sustained by an infection inside the root canal system, and a marginal lesion caused by plaque accumulation on the outer surface of the tooth and root. Under certain clinical conditions, it is possible that the disease of one tissue compartment causes the disease of another. A correct diagnosis can also be made more difficult due to the simultaneous presence of periodontal disease as well as endodontic disease on a tooth **(endodontic – periodontal lesion)**.

Furthermore, advanced periodontal lesions can, more rarely, be caused by fracture or iatrogenic perforation of the root. Knowing the pathogenesis of these syndromes and making correct diagnoses are decisive in effective therapy and in preventing iatrogenic periodontal lesions resulting from incorrect treatment on the marginal periodontium.

2.4 Early onset and rapidly progressing periodontal diseases

A small group of rare, often severe and rapidly advancing forms of periodontitis is subsumed under the designation "early onset periodontitis". These forms of periodontitis are frequently characterized by early clinical occurrence and a family history of the disease (Page et al. 1983). In most cases early infections with **highly virulent bacteria** and **individual susceptibility** to periodontal diseases are in evidence. At all events, the presence of systemic diseases which significantly weaken the immune system are to be excluded by means of differential diagnosis. Depending on the age at which the onset occurs and the manifestations of the disease, it is possible to distinguish between prepubertal periodontitis, localized juvenile periodontitis, generalized juvenile periodontitis and rapidly progressing periodontitis, which can affect both the deciduous teeth as well as the permanent teeth.

2.5 Periodontal diagnostics

Periodontitis is characterized clinically by inflammation of the affected gingiva (in particular reddening and swelling), and by an increased tendency to bleed on probing (BOP). The periodontal tissue often shows reduced resistance to probing, gingival pockets and gingival recession. Typical in the advanced stages are tooth mobility or loosening of the dental arch, tooth drifting or elongated teeth. Negative papillae also frequently occur.

Fig. 2 - 3 *Clinical findings on a 41-year old patient with advanced periodontitis.*

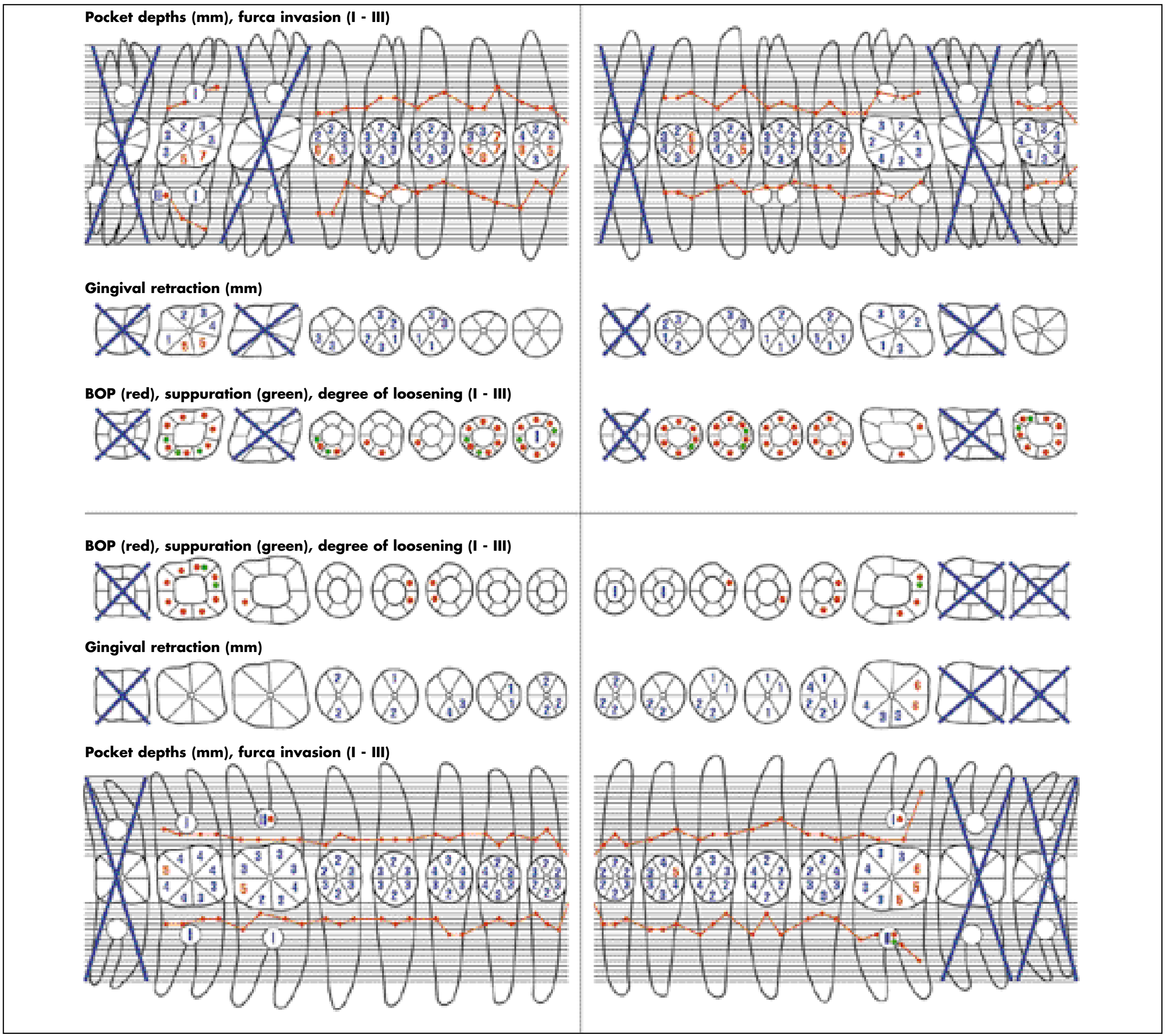


Fig. 2 - 4 *Clinical periodontal charting on the above patient with documented sulcus probing depth and gingival recession, attachment level drawn in (red line), proven furca invasion and loosening of teeth, as well as indexed positive bleeding on probing (BOP) and pus drainage on probing (suppuration).*

Fig. 2 - 5 *Circular probing with pressure-calibrated periodontal probe at a standardized contact pressure of 0.2 N (e.g. probe no. DB765R Aesculap, Tuttlingen, Germany).*

On the X-ray periodontitis is shown by moderate or severe periodontal bone loss (horizontal or vertical bone loss). The X-ray image also supplies valuable information for excluding lesions of endodontic origin. Histologically, periodontitis is characterized by an inflammatory infiltration.

Successful treatment demands correct diagnosis and a differential diagnostic evaluation, in particular in relation to endodontic factors or general medical conditions and reproducible documentation of findings.

Fig. 2 - 6 *Oral X–ray film status created using the paralleling technique with orthoradial ray path, using intraoral film mount holders and lead screens for delimiting the ray field equivalent to the film size (e.g. RWT window X-ray film mount holder, Kentzler & Kaschener Dental, Ellwangen, Germany).*

A standardized, periodontal diagnostic procedure and comparable documentation are important prerequisites for the reproduction of findings and for recording changes in findings following therapeutic measures. Frequently it is only possible to record the **dynamics of the progress** of the disease by continuous monitoring of the patient in order to determine recall intervals for supportive periodontitis therapy (maintenance therapy) which are to the requirements of each individual patient. The basis of all dental diagnostics is a detailed **general medical and specific anamnesis**. Important indicators for the general health are not infrequently derived in this way, e.g., systemic diseases to be clarified by interdisciplinary means by a specialist in internal medicine, for example. Dental findings should note the condition of the intraoral and extraoral mucosa, the hard substances of the teeth and dental restorations. Particular attention should be paid to the recording of diseases of the mouth and mucous membranes, lesions of the hard substance of the teeth (erosion and caries) and defective restorations (poor marginal obturation, excessive contour, subgingival extension, blocked interproximal areas, missing approximal contacts, etc.). A **sensitivity test** (e.g., with dry ice) documents the sensitivity of the teeth and, together with the intraoral X-ray film status (Fig. 2 - 6), provides important information on the assumed vitality of the teeth or indications of endodontic lesions. In general it may be assumed that vital teeth do not produce sufficient irritation to produce a pathological process in the periodontium (Langeland et al., 1974).

Specific **periodontal charting** (Fig. 2 - 4) is based on a circular probing of the periodontium of all the teeth using a recommended contact pressure of approximately 0.2 N. The use of a pressure calibrated probe (Fig. 2 - 5) facilitates reproduction of the measured values. This measurement should be taken on all the surface of all the teeth, documenting the deepest value for all tooth surfaces (at least six measuring points per tooth). The **pocket depth** (PD) is the distance between the gingival margin to the base of the gingival pocket. "Pocket measurement" alone, however, does not provide information as regards actual loss of attachment, due to the frequent presence of inflammatory gingival oedema or gingival recession. Attachment loss should therefore be measured by also examining and recording gingival recession at the same measuring points (or gingival hyperplasia as an indication of pseudo pockets). **Gingival recession** or hyperplasia is recorded by measuring the distance between the present or reconstructed (e.g., from the neighbouring tooth level) cemento-enamel-junction and the gingival margin. The total of the PD and gingival recession gives the **attachment level** (Fig. 2 - 4). Assessment of the furca invasion can be undertaken using a curved periodontal probe (e.g., the Nabers probe). Three levels of severity can be distinguished according to the loss of horizontal support:

Grade I: Horizontal loss of support < 1 / 3
Grade II: Horizontal loss of support > 1 / 3
Grade III: The furcation can be explored completely.

Tooth mobility is also recorded and documented according to levels of severity (grades I - III). If occlusal trauma is suspected, a **clinical functional analysis** is recommended.

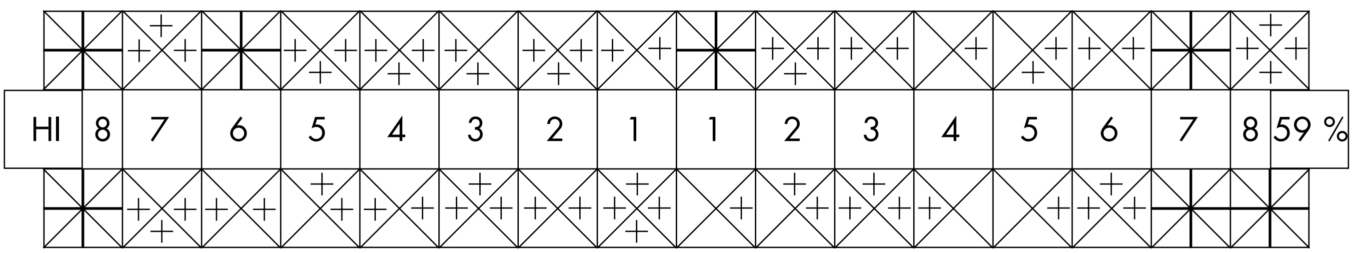


Fig. 2 - 7 - 1 *Hygiene index (HI) according to coloration using plaque revealing solution (in this example 59 % of the surfaces evaluated are affected by plaque)*

In each case, the presence of inflammation is also documented on all sites by recording pockets which start to bleed during the examination with a probe (**bleeding on probing**: BOP) (Fig. 2 - 4). Delayed slight bleeding of gingival origin is generally not documented. The most serious symptom of advanced acute destruction of periodontal tissue is the discharge of pus from a pocket (**suppuration**), which often can be detected only under relatively dry conditions (Kaldahl et al., 1990). This, too, if present, must be specifically recorded in the periodontal charting (Fig. 2 - 4).

Before periodontal therapy a complete oral X-ray film status is required (individual intraoral X-rays, not a panoramic), from which the position of the alveolar bone and the course of the buccal and lingual bone ridge can be seen (Fig. 2 - 6). Furthermore, the X-ray supplies important information for excluding lesions of endodontic origin or endodontic involvement. During recall more or less regular X-ray checks are required. The necessary comparison of X-rays taken at different times calls for a standardized X-ray technique, preferably the paralleling technique with orthoradial ray path. Intraoral film holders with lead screens are recommended, in order to restrict the ray field to the size of the film, which in critical patients can be customized with thermoplastic material, for example, and can be repositioned in future with reproducible occlusal bite locations. Not least, it is necessary to establish the patient's **oral hygiene status** (Fig. 2 - 7 - 1), for which it is recommended that the presence or absence of plaque be documented by coloration of the plaque using plaque revealing solution. The status of oral hygiene is an important finding for optimizing the patient's oral hygiene and for motivating the patient to maintain it. It can also provide information for setting recall intervals during the supportive periodontal therapy.

Recently a group of high risk patients has been identified by a simple test on specific interleukin 1 genotypes. In these patients the production of the body's own inflammatory mediators may be increased, which can accelerate periodontal destruction.

In patients with critical findings or with what are assumed to be rapidly progressing types of the disease, which are generally revealed only after the conclusion of the initial treatment during the first reevaluation of the findings (preferably 4 - 6 weeks after the initial treatment), a **microbial analysis** of samples taken from the gingival pockets is recommended. These are taken under standard conditions by means of a sterile paper tip, and the genetic make-up is duplicated (i.e. using the PCR method) with subsequent genetic identification of critical species of bacteria, such as Aa, Pg, Pi, Bf or Td (Fig. 2 - 7 - 2).

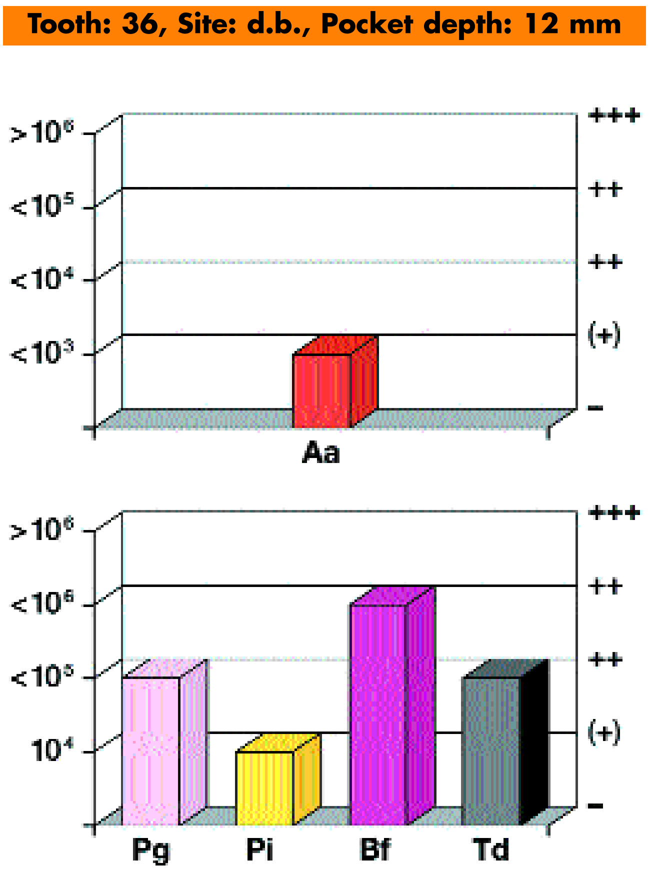


Fig. 2 - 7 - 2 *Example of a PCR gene probe test for identifying critical subgingival bacteria in quantitative relationship to the total bacterial load.*

Aa = Actinobacillus actinomycetemcomitans
Pg = Porphyromonas gingivalis
Pi = Prevotella intermedia
Bf = Bacterioides forsythus
Td = Treptomena denticola

(e.g., microDent Test, Advanced Diagnostic Systems ADS, Nehren, Germany)

2.6 Cause-orientated, minimally invasive periodontal therapy with particular focus on the Vector Method

Numerous animal studies and clinical longitudinal studies have shown that **eliminating or controlling the subgingival biofilm** and the supragingival plaque can create a healthy environment for both the teeth and periodontium in most, if not all cases (Ramfjord et al. 1968, Axelsson & Lindhe 1978, 1981, Lindhe & Nyman 1975, 1984). Even in the case of early onset periodontitis with rapid progression of the disease, where it is not possible to create healthy conditions in every case, the mechanical removal of the biofilm is an important condition for arresting the progress of the disease, along with additional therapy, such as antibiotics. Successful periodontal therapy is divided into several stages, which build on one another in a consistent way.

In the pretreatment **hygienic conditions** are created and areas encouraging plaque accumulation are eliminated. In particular, this involves opening up blocked approximal spaces, correcting inadequate approximal contacts, eliminating medium-sized and large carious defects and recontouring overhanging restorations. If this cannot be achieved satisfactorily by subtractive or simple additive measures, individual restorations affected should be removed, defects temporarily prepared and an adequate long-term restoration should be carried out. Non-viable teeth are removed at this stage in the therapy. If there are endodontic causes for marginal lesions, or if these causes play a part, cause-orientated endodontic treatment of these teeth is carried out, in most cases without endosurgical measures. Parallel to this, the patient is instructed individually in relation to adequate oral hygiene techniques and the use of oral hygiene aids appropriate to his situation. Supragingival calculus and calculus located at the entrance to the pockets is not removed during an initial treatment, if the maintaining of hygienic conditions is not affected. Temporary healing and firming of the marginal gingiva, restricting therapeutic access for the actual therapy of deeper periodontal tissue areas is therefore avoided. By dispensing with such initial, but incomplete treatment of the diseased periodontal tissue, the danger of periodontal abscesses following incomplete treatment is also minimized.

Cause-orientated therapy is aimed at **effective removal of the biofilm associated with the subgingival root surfaces** and the supragingival deposits (principle of a full mouth desinfection). If the deposits have mineralized in the form of calculus, the removal of these deposits is an important prerequisite to achieve effective removal of overlaid, settled or adjacent biofilms or plaque deposits. Special care must be applied to protect tissue structures which are important for regeneration or for supporting regeneration, especially the root cementum and the soft tissue in the pockets. Nyman et al. have proved that when the root is intensively smoothed with removal of the root cementum, no additional healing effect can be achieved as compared with the careful use of the instruments, leaving the cementum intact (Nyman et al., 1986, 1988).

It is likely, however, that especially in the case of vital teeth, posttherapeutic hypersensitivity can be minimized by leaving of the root cementum or the dentine intact. Additional flap surgery or soft tissue curettage going beyond the mechanical removal of the biofilm would not be able to remove problem bacteria such as Actinobacillus actinomycetemcomitans (Aa) successfully even in early onset periodontal diseases (Christersson et al., 1985).

Local antibiotic applications or systemic antibiotic administration are not necessary in most cases – with the exception of early onset, rapidly progressing types of the disease.

Cause-orientated periodontal treatment follows a **reevaluation of the findings**, from which further periodontal, endodontic, functional or restorative treatment measures are derived. Subsequent supportive periodontal therapy should counter reinfection at recall intervals which are orientated to the requirements of each individual patient.

Fig. 2 - 8 *Vector curette. The approximal tooth and root surfaces are treated with the Vector curette by using an access via buccal (labial) and lingual or palatinal. The slender shape and the minimal thickness of the curette allow easy handling even in narrow approximal spaces. In the case of deep intrabony pockets the end of the instrument is introduced more or less vertically into the pocket.*

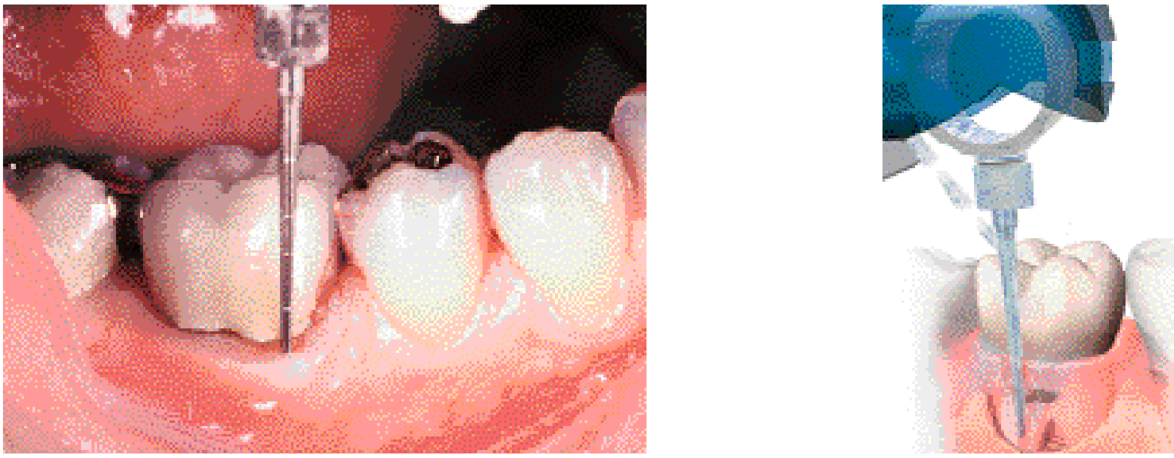


Fig. 2 - 9 *Straight Vector probe. The buccal (labial) and lingual (palatinal) tooth and root surfaces are treated with the Vector lancet (sites with pocket depths up to 5 mm) or the straight Vector probe (sites with pocket depths deeper than 5 mm). The instrument is handled in a similar way to a periodontal diagnostics probe, using the same contact pressure and with tactile feedback against the base of the pocket and against the tooth surface. The instrument is guided circularly and in tangential linear fashion around the surface sections undergoing treatment.*

Fig. 2 - 10 *Curved Vector probe. Mesial, distal, lingual or buccal furcations as well as the concave surfaces around the enamel-cementum junction are treated with the curved Vector probe. It has been proven that the furcation areas are best preprobed initially with an inactive instrument, allowing the instrument to turn inward following its curve. After safe localization of the furcation surfaces are requiring treatment the instrument is activated and the surfaces are treated with the instrument.*

Through its indirect application of energy via the fluid film surrounding the instrument **(warning: do not evacuate excessive liquid directly at the sites being treated)**, and the support of hydroxyapatite particles, which act smiliar to a dentifrice, the Vector system allows for the very effective removal of the biofilm and plaque, sub- and supragingivally. The typical pulse transfer enables for removal of calculus, without damaging the "soft" cementum and dentine surface or the soft tissue of the pockets. A biological acceptable surface is achieved in a reliable matter during the repolishing of the root surfaces with the hydroxyapatite slurry. The characteristic of the system is that it avoids extensive mechanical processing, thus also allowing gentle treatment of sensitive tooth restoration surfaces, especially in marginal areas. The main reason for this high efficiency is the design of the instruments, which is based on minimally invasive criteria, allowing tactile, sensitive instrumentation with maximum tissue protection even in poorly accessible areas, such as furcations. The straight and curved probes are furnished with the same measuring scales (3 mm – 3 mm – 2 mm – 3 mm) as conventional periodontal diagnostic probes, and allow better orientation during subgingival probing deep in the pocket.

Fig. 2 - 11 *Scanning electron microscope image of a tooth and root surface treated with the Vector curette (on the left of the picture) using a ultrafine hydroxyapatite slurry. The natural surface topography and the hard tissue are largely preserved apart from slight polishing effects, and adsorbed deposits, mineralized deposits and biofilms are effectively removed.*

Since the Vector Method is easily accepted by patients, in many cases it is possible to treat all of the subgingival and supragingival surfaces (often without using anaesthesia) in one session, which has a favourable effect on slowing the rate of reinfection.

Additional, manual smoothing of the surfaces using hand instruments, such as curettes, as recommended for many traditional sonic or ultrasonic instruments (Björn & Lindhe, 1962), is not necessary for root surfaces treated with the Vector instrument, and should be avoided in order to prevent damage to the hard tooth tissue (Fig. 2 - 11). Any blackish discolorations which may occur on ceramic restoration surfaces are due to microscopic abrasion from the metal instruments and can be selectively removed by subsequent use of non-metal probes or by means of traditional polishing pastes.

The **high tactile sensitivity**, achieved by the elimination of vibration in the instrument, allows for both exploration and therapeutic use of the tool on the treated surfaces. The instruments are guided horizontally and/or vertically along mineralized deposits (calculus) until they are removed by touch-sensitive feedback. In cases of doubt, the pocket sections concerned can be expanded using compressed air and checked visually. For sites with extensive calculus deposits or overhanging restorations, these can be removed using the same instrument in combination with an abrasive silicon carbide suspension (Vector Fluid abrasive). If necessary, traditional polishing pastes and rotating brushes, etc. can also be used for removal of massive supragingival staining. The treatment can be concluded beneficially by professional fluoride application to all the tooth surfaces, e.g., with highly concentrated fluoride gels.

The following **treatment system** guarantees the most effective and efficient Vector therapy: initially, all approximal surfaces are treated with the Vector curette (shown in blue on Fig. 2 - 12). This is best done by starting at the palatinal (lingual) side of the first quadrant and continuing with the instrument held in the same way (the instrument at a 90-degree angle to the right, viewing in the handpiece direction) cleaning the buccal (labial) surfaces in the second quadrant. The instrument is then turned by 180 degrees (instrument adjusted at a 90-degree angle to the left, viewing in the handpiece direction). Then follows treatment of the other contralateral surfaces which are accessible in the second quadrant on the palatinal (lingual) side and in the first quadrant on the buccal (labial) side.

Next is the treatment of the furcations with the curved Vector probe (shown in green in fig. 2 - 12), adjusting the probe to a 90-degree angle to the left. In this way the buccal furca openings of the right molars and, in the lower jaw, also the lingual furca openings of the left molars can be reached. The contralateral furcations are probed with the instrument adjusted 90 degrees to the right. To reach the mesial furca openings, the curved probe is inserted at an angle of approximately 20 degrees to the handpiece longitudinal axis (either to the right or to the left depending on the treatment of the patients right or left half of the jaws), and slanting forward. The distal furca openings are reached by using the probe adjusted at an angle of 20 degrees to the handpiece, to the right or left. Lastly, the buccal and lingual surface of the teeth and roots are treated using the Vector lancet (sites with pocket depths up to 5 mm) or the straight Vector probe (shown in red in Fig. 2 - 12; for sites with pocket depths deeper than 6 mm). The tool must be guided along the tooth surface in a tangential, linear way. To treat the maxilla, a right-handed user should sit in a position between 12 - 2 o'clock to the patient, who is lying down. An ambidextrous practitioner can treat the buccal tooth surfaces of the first quadrant and the lingual tooth surfaces of the second quadrant with his left hand, whilst seated in the usual position (between 9 and 12 o'clock). To treat the mandible, it is recommended that the patient is sitting in an inclined position and that the practitioner works from a position between 9 and 12 o'clock.

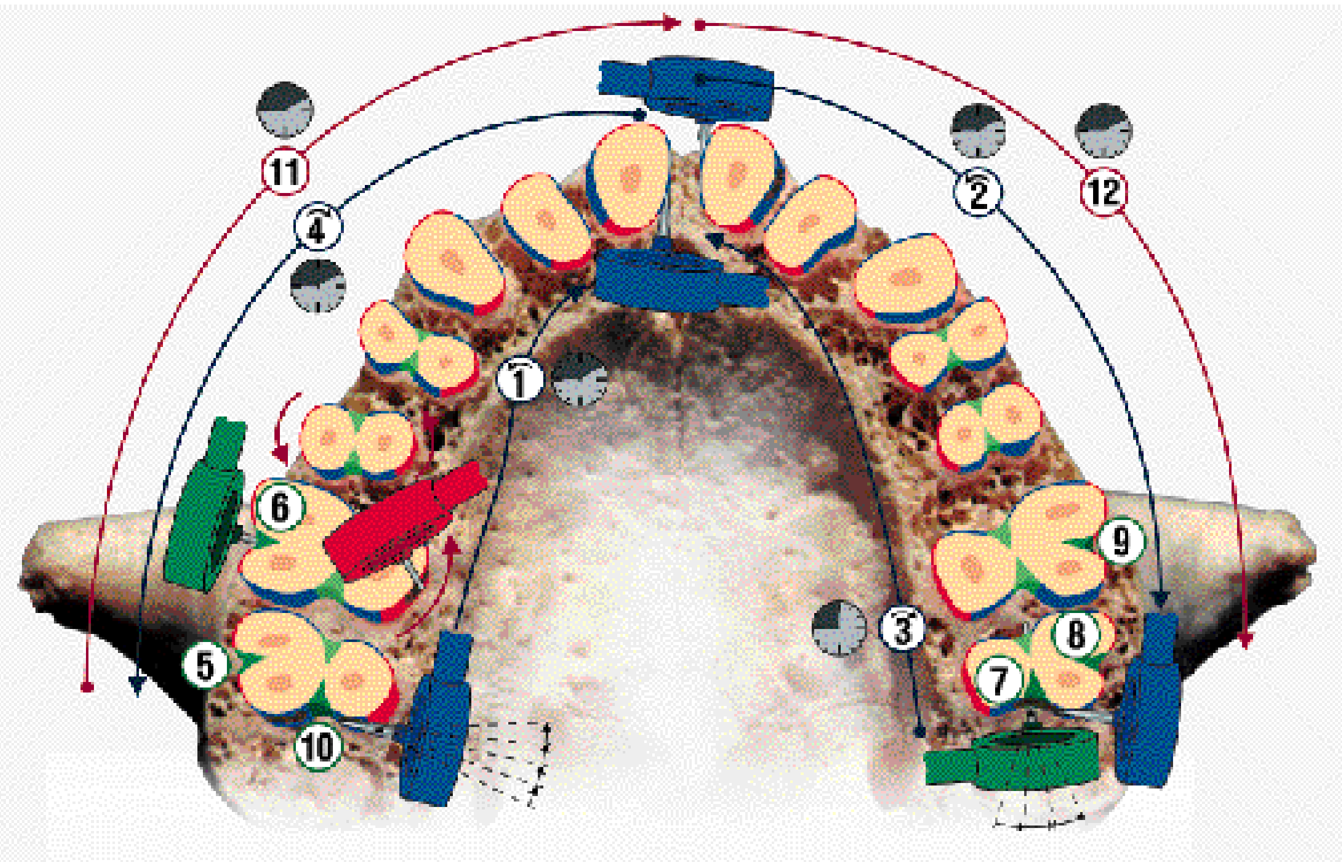


Fig. 2 - 12 *Treatment concept on the maxilla using the Vector Method.*

Four to six weeks after the initial periodontal treatment, a **reevaluation** of the main findings is necessary. The sulcus probing depths, gingival recession, furca invasion, mobility of the teeth, bleeding on probing, suppuration and plaque accumulation are again documented. This newly obtained data is indispensable as a reference for the frequency of recalls for supportive periodontal therapy. The clinical signs of inflammation should have largely disappeared, and the sulcus probing depth should be reduced in most areas (Kaldahl et al., 1988). Some teeth will present less mobility and there should be diminished gingival recession, mainly because of the subsiding of swelling of the marginal gingiva. In most cases, the attachment level may not have changed significantly in so short a time.

Individual pockets that are still bleeding on probing at this stage should again be evaluated by diagnosis and differential diagnosis, and should be examined for residual subgingival calculus, plaque retention sites, insufficient approximal contacts, missed residues of luting cements, significant plaque accumulations or root configurations which are particularly difficult to access, all may have been left from the initial therapy.

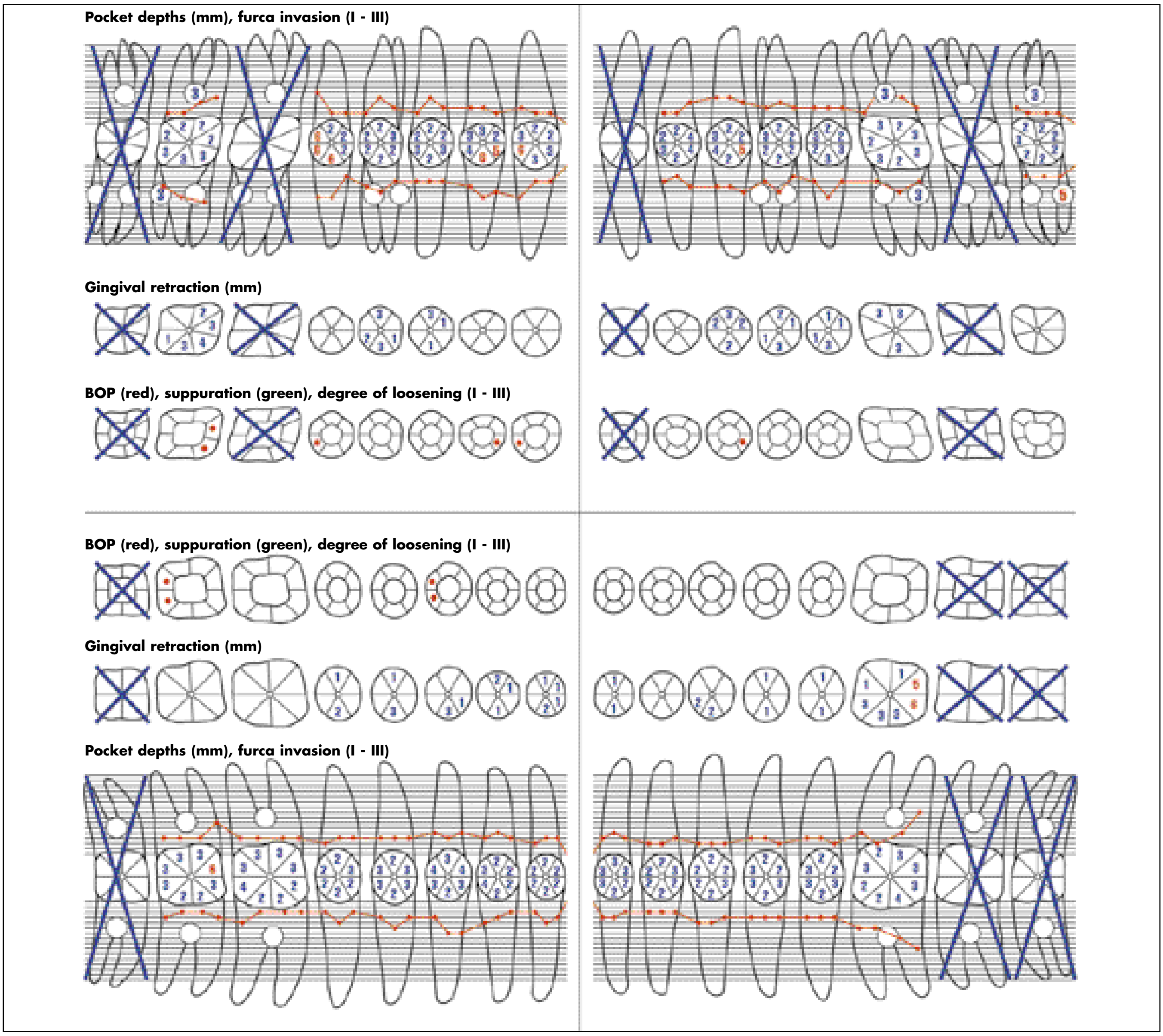


Fig. 2 - 13 *Clinical periodontal charting on the patient from Fig. 2 - 4 six weeks after initial Vector therapy. A few sites, which are without exception associated with inadequate restorations, show persistent inflammatory signs (positive BOP). The restorations were recontoured and finished and these sites were selectively retreated with the metallic Vector instruments.*

Careful retreatment with the same instruments used in the initial treatment and a subsequent manual check are carried out. In cases of doubt, a sharp curette can be used as a diagnostic instrument without applying much contact pressure, to check that all hard deposits have been completely removed. At this stage it will be necessary to evaluate the maintainability of the teeth, and the need for hemisections or root amputations, as well as the removal of plaque retention sites by restorative measures. Gingival pockets which do not show bleeding on probing are not treated during this check. Supportive periodontal therapy will follow directly; a three-month interval is recommended as a first recall (Axelsson et al., 1991). At least once a year, dental findings, sensitivity, gingivitis, pathologically deepened pockets, furcations, tooth mobility and changes in bone level should be diagnostically reevaluated. Whilst in many cases, this reevaluation of findings and supportive periodontal therapy will suffice once a year, some patients may require checks and prophylaxis therapy more often; a small number of patients even once a month.

2.7 Treatment of early onset and rapidly progressing periodontal disease

Successful treatment of early onset periodontitis is mainly dependent on early diagnosis, causally orientated therapy directed against the bacteria concerned and consistent supportive periodontal therapy (maintenance therapy) at recall intervals based on requirements. As well as removing the biofilm and the objective of reducing the quantity of subgingival bacteria, **specific elimination and suppressing the growth of highly virulent anaerobic bacteria**, such as Actinobacillus actinomycetemcomitans (Aa), Porphyromonas gingivalis (Pg) or Bacteriodes forsythus (Bf), are central to the therapy.

Mechanical removal of the biofilm alone is frequently not enough to eliminate these highly virulent bacteria to a sufficient degree in patients with early onset periodontitis and rapidly progressing forms of the disease (Kornman & Robertson, 1985). Additional flap surgery or soft tissue curettage are also subject to these limitations (Christersson et al., 1985).

In these cases, therefore, the systemic administration of antibiotics is recommended as an additional measure to the mechanical removal of the biofilm. The effect of antibiosis is determined to a great extent on the quality of the removal of the subgingival biofilm, as if this is intact, it protects the target bacteria from the antibiotics (van Winkelhoff et al., 1996). The choice of antibiotic depends, in the individual case, on the composition of the pathogenic subgingival bacterial flora. Combinations of metronidazole (e.g., Clont, Bayer, Leverkusen, Germany) plus amoxicillin (e.g., Amoxicillin, Ratiopharm, Ulm, Germany) have proved particularly effective in cases of infection with Aa and Pg, and significantly or entirely eliminate Aa and other pathogenic, subgingival microorganisms from periodontal lesions and also from other oral sites subject to colonization (e.g., the back of the tongue or the tonsil recesses), generally after application of 8 to 10 days (Kornman et al., 1989, van Winkelhoff et al., 1989, 1992).

In most cases a gradual approach is recommended. Firstly, traditional initial periodontal therapy, which, after creating hygienic conditions, and instructing the patient in oral hygiene, serves for careful removal of the subgingival biofilm and dental hygiene. 4 to 6 weeks later the main findings are reevaluated in the normal way. In the case of generalized, persistent periodontal lesions, a microbial analysis is recommended (Fig. 2 - 7 - 2). In another phase of therapy the removal of the subgingival biofilm is repeated with equal care, and antibiotics which are as far as possible targeted towards the pathogen spectrum, or, in many instances, combinations of antibiotics, are used parallel with and immediately after the mechanical cleaning. It is recommended that the microbiological test is repeated after 4 to 12 weeks, to check the elimination or suppression of the virulent bacteria which are causing the problem. Subsequent supportive periodontal therapy should prevent a recurrence or reduce further progression of the disease if recall intervals are adjusted to requirements and consistently observed.

2.8 Contraindications

As a general rule, instruments and devices driven by ultrasonic motors should not be used on patients with cardiac pacemakers or with sensitive, e.g., implanted drug dosing systems or pumps.

Patients who suffer from a blood disease should be treated only after consultation with the internist in attendance.

Within 6 months after a heart attack, a patient should not undergo surgical or invasive treatment. These patients are often taking anticoagulants, which increase the risk of excessive bleeding. At all events, either the internist or cardiologist concerned must be contacted before treatment.

The bacteremia occurring during periodontal treatment or even during dental hygiene may endanger patients suffering from rheumatic endocarditis, congenital heart defects and those patients with cardiac or vessel implants. Before periodontal examination, but at all events before periodontal therapy or extensive dental hygiene, these patients should rinse the mouth twice with a 0.2 % chlorhexidine-digluconate solution for 20 seconds each time, in order to reduce the intraoral bacterial flora. An antibiotic should be given an hour before periodontal therapy or dental hygiene. For adults, the American Heart Association (1997) recommends 3 g of amoxicillin 1 hour before the intervention. For those allergic to penicillin, clindamycin may be administered.

After organ transplants, most patients take drugs to prevent organ rejection. Many of these drugs cause gingival hyperplasias. Rinsing the mouth with antiseptic solutions and antibiotic therapy are recommended before periodontal therapy and extensive dental hygiene measures.

Patients who suffer from diabetes mellitus are more prone to infections and often experience problems with the healing of wounds. Furthermore, there is a risk of arteriosclerosis. Only stabilized patients should be treated, and it is vital that the attending internist is consulted.

Wound healing is also negatively affected by nicotine addiction. This does not necessarily mean that smokers cannot undergo periodontal therapy. However, the success of periodontal treatment is usually limited in the case of heavy smokers (Ah et al., 1994).

2.9 Supportive periodontal therapy

As a supplement to the initial periodontal diagnosis, which records the results of the progress of the disease to date (inflammation, pocket formation, attachment loss, tooth mobility), diagnostics during the supportive periodontal therapy (maintenance therapy) documents the change in the repaired or regenerated condition of the periodontium achieved by the initial treatment and by the recall treatments to date. The reference point here is the periodontal charting documented 4 to 6 weeks after the initial therapy and the last documented recall condition (Claffey, 1991).

Under optimal conditions, the **regular infection control** forming part of supportive periodontal therapy is aimed at long term maintenance of the periodontal conditions and attachment level achieved after the initial treatment. A balance is sought between subgingival bacterial infection and the immune reaction. The initial setting of recall intervals will be made taking into account the risk factors. Taking the general findings and the compliance of a patient suffering from periodontitis into consideration, the major **risk factors** are nicotine abuse, significant attachment loss in relation to the age of the patient, a persistent tendency to bleeding or poor oral hygiene. Risk factors relating to the teeth or the teeth surfaces include abnormal positions of the teeth, in particular dysgnath teeth, furca invasions or iatrogenic plaque retention sites, which are often associated with extended subgingival tooth restorations (Lang et al., 1983).

For a long-term success of all the periodontal treatments it is crucial to reevaluate the pockets and inflammatory site activity continuously during the recall as well as to reinstrument sites before upcoming recurrent inflammation. Only by accurate monitoring of the pockets and regular professional dental hygiene in combination with the regular destruction of the subgingival biofilm reinfection can be prevented or delayed (Axelsson et al., 1991; Isidor & Karring, 1986; Kahldahl et al., 1988).

Reinfections at the beginning of the supportive periodontal therapy are frequently the result of partially inadequate initial therapy. Generally such sites can be detected by positive bleeding on probing. These sites are to be retreated with particular care, in order to remove any missed residues of biofilm or calculus (warning: atraumatic process with maximum care taken in respect of the hard dental tissue and the soft tissues of the pockets). If it is suspected that subgingival calculus have been missed during the initial treatment, the Vector Method recommends the use of metal instruments. Otherwise instruments made of fibre composite materials are available for supportive periodontal therapy, as these are specially adapted to the requirements of supported periodontal therapy. These **"recall" instruments** are shaped in analagous to the metal instruments used for the initial treatment and flexible for easier adaptation to the complex root surface topography. Recurrent biofilm can be effectively removed also in combination with ultrafine hydroxyapatite slurry (Vector Fluid polish). Due to the filigree instruments made of a soft fibre-reinforced composite and the use of the fine-grained hydroxyapatite slurry with a surface hardness of the particles adjusted to the wear sensitive dentine tooth substrates and soft tissues are reliably protected. The formation of tulip-shaped teeth, which is well known as a frequent consequence of regular periodontal maintenance therapy with excessive wear on the hard substances of the teeth, is therefore reliably prevented.

Although not all sites with persistent inflammatory signs (positive BOP) indicate imminent loss of periodontal supportive tissue. However, the presence of numerous pockets which bleed on probing are considered as an indication that recall intervals should be shortened and that more intensive prophylactic measures should be taken. For patients whose situation has been stabilized, but who nevertheless show individual sites which prove resistant to therapy, additional application of local medication carriers, such as tetracycline-containing periodontal threads (e.g., Actisite, Wybert, Lörrach, Germany) or antimicrobial gels containing metronidazole (e.g., Elyzol-Dentalgel, Dumex, Bad Vilbel, Germany) or chlorhexidin slow releasing chips (Perio-chip, Atid Pharma, Alzenau, Germany) could be considered in individual cases.

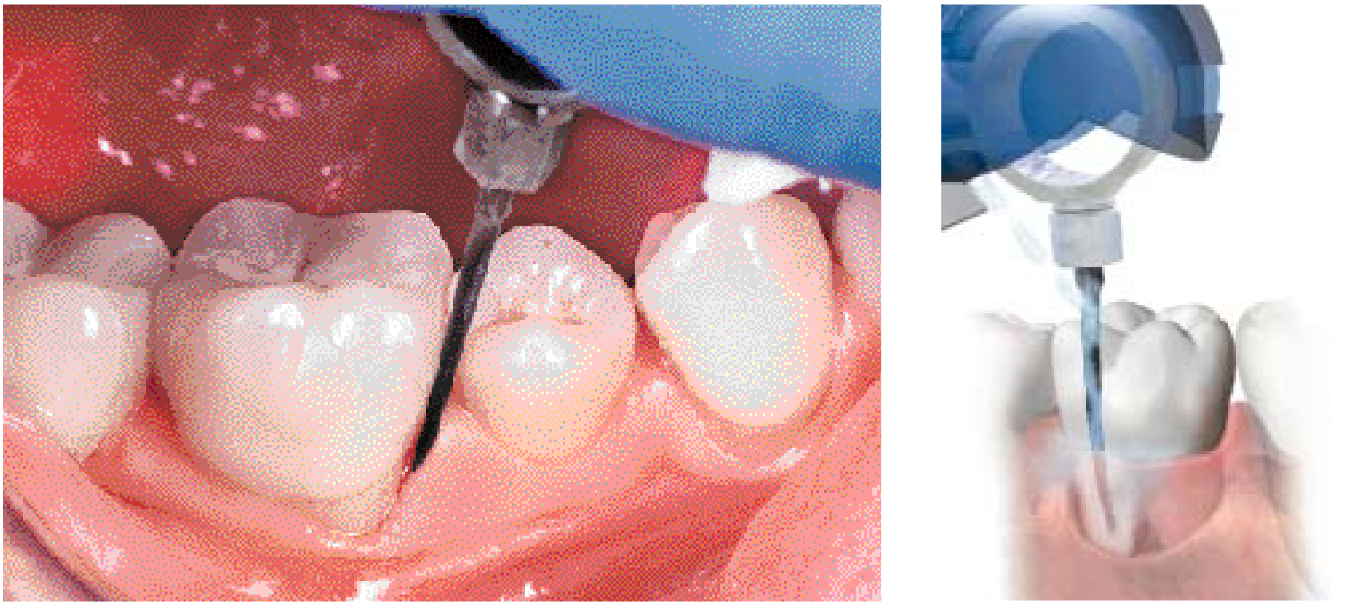


Fig. 2 - 14 *Vector recall probe. Thanks to this instrument's flexibility and filigree design, according to minimally invasive criteria, in many cases all the surfaces of the teeth and the periodontal sites can be treated during the supportive periodontal therapy. The instrument is used similarly to the metallic Vector probe. Using the habitual probing pressure against the base of the pockets and the tooth surfaces the instrument is guided in tangentially around the teeth. The tactile feedback of the active instrument infrequently allows differentiation of an intact epithelial attachment. Such sites are treated very cautiously or they are only partially treated with the instrument if there are no signs of inflammation. Discolorations from abraded material are also prevented on sensitive ceramic tooth restorations. The instrument is suitable for subgingival and supragingival use.*

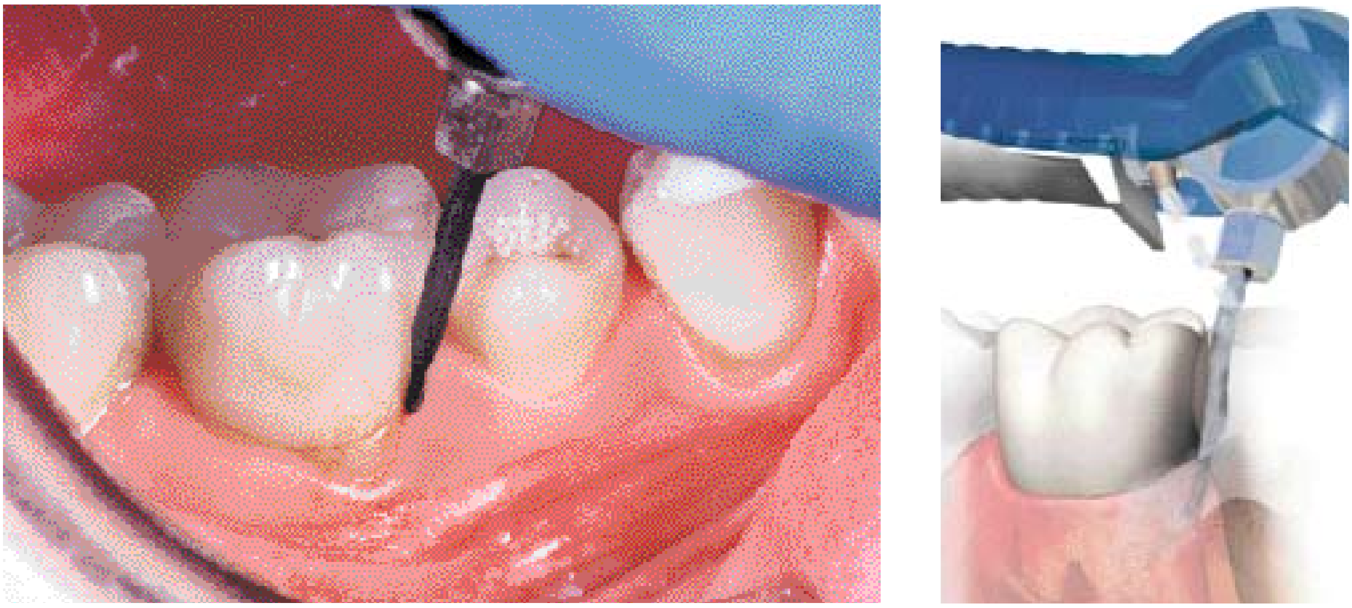


Fig. 2 - 15 *The Vector recall curette is used for supportive periodontal therapy on approximal tooth and root surfaces which cannot be reached with the straight recall probe. The instrument is used in the same way as the metal Vector curette. The slender shape and the minimal thickness of the instrument tip, and, in particular, the flexible working end and the partly flexible shaft allow safe, touch-sensitive handling even in narrow approximal spaces. In the case of deep intrabony pockets the end of the instrument is introduced more or less vertically into the pocket*

If the patient is remotivated or reinstructed in oral hygiene, it is beneficial in many cases to check the hygiene status again a few weeks later. Usually during supportive periodontal therapy is also supragingival staining is removed. It is recommended that all teeth treated are dried as far as possible and fluoridated, preferably using highly concentrated adhesive gels (e.g., Duraphat, Colgate, Hamburg, Germany). In this way surface-associated deposits and accumulations of fluoride ions are reconstructed. In order to prevent root caries, in particular in older patients with generalized gingival recession and/or a reduced flow of saliva, highly concentrated chlorhexidine varnishes (e.g., EC 40, Explore, Nijmegen, NL) are suitable, which are applied on the exposed surfaces after drying.

When non-inflammatory conditions and stabilization have been achieved over several recall intervals, regenerative periodontal measures may be considered in the individual case independently of periodontal therapy. In choosing the various materials and techniques it is important to note, however, that hitherto many of these options, for reasons of methodology, are obliged to use initially surgery techniques and generally involve considerable posttreatment supportive care.

Fig. 2 - 16 *The curved Vector periodontal probe (metal) can also be used for supportive periodontal therapy in the furcation area if these surfaces are out of reach of the straight recall probe or the recall curette.*

2.10 Case studies

Case 1: "Criteria for successful treatment"

The example below of a 54 year old male patient with advanced marginal adult periodontitis illustrates the criteria used to assess a successful treatment.

The patient's anamnesis was unremarkable. With the exception of the information that both parents had already lost their teeth at an early stage, there was no indication of risk factors such as, for example, serious general diseases or nicotine abuse. The clinical examination revealed an insufficiently cared for set of teeth from conservative and prosthetic aspects (Fig. 2-17). Apart from the root canal treated tooth 16, all teeth reacted sensitively to dry ice with tooth 26 revealing a delayed reaction. The analysis of oral hygiene revealed adequate proximal contacts and a massive coating of plaque, particularly proximal and cervical. A large amount of restoration work indicated overcontoured subgingival margins. The clinical function diagnosis produced evidence of a compensated functional disturbance. The clinical and radiological periodontal findings revealed partially deep bony defects with massive periodontal inflammation (multiple bleeding on probing) with partially acute episodes (countless pockets with suppuration) (Fig. 2-18, 2-19). A genetic susceptibility test for periodontis was made to determine an increased periodontogenetic risk (Paro Gen Test, (IAI Institute, Zuchwil, Switzerland). The result (IL-1A [-889] mutated heterozygot; IL-1B [+3953] mutated heterozygot) indicated the probable presence of a genotype risk. The subgingival probes obtained with sterile paper tips at tooth positions 26 mesio-buccal (Probing depth: 13 mm), 16 disto-buccal (Probing depth: 12 mm), 37 mesio-buccal (Probing depth: 8 mm) and 46 mesio-buccal (Probing depth: 6 mm) revealed no indication of an infection with Actinobacillus actinomycetemcomitans or with Porphyromonas gingivalis (see Section 2.5).

After a thorough examination, an initial periodontal treatment was carried out in one session (full mouth desinfection principle). This consisted of recontouring all overcontoured restorations plus considerable shortening of the subgingival extended crown margins to a paragingival or supragingival level using rotating diamond burs and files (Fig. 2-20).
Particular care was required for the restoration of a proximal accessability with a thin interdental brush. Finally, the Vector method was used for the careful subgingival and supragingival cleaning of deposits, biofilm, calculus and plaque from all teeth using metallic instruments and aqueous hydroxyapatite slurry (Vector fluid polish and water). Anesthesia was unnecessary up to the anterior part of the maxilla. Medicinal treatment was not administered.

Six weeks after the initial treatment, the findings were re-evaluated using a pressure-calibrated probe (Fig. 2-21). The periodontal inflammation was healed apart from several individual locations with positive bleeding on probing (Fig. 2-22). These were re-instrumented selectively with the Vector system during the evaluation of findings. No further treatment was given. The next re-evaluation of findings was scheduled for three months later.

Criteria for successful treatment:

- Elimination of suppuration (pus exudation from the pocket)
- Considerable reduction in the number of bleeding pockets with standardized probing (e.g. pressure-calibrated probe)
- Significant reduction in pocket depth
- Securing of loose teeth
- Attachment gain
- Reduction of the typical inflammatory fetor ex ore

Fig. 2-17 *Initial clinical findings with massive gingival and periodontal inflammation*

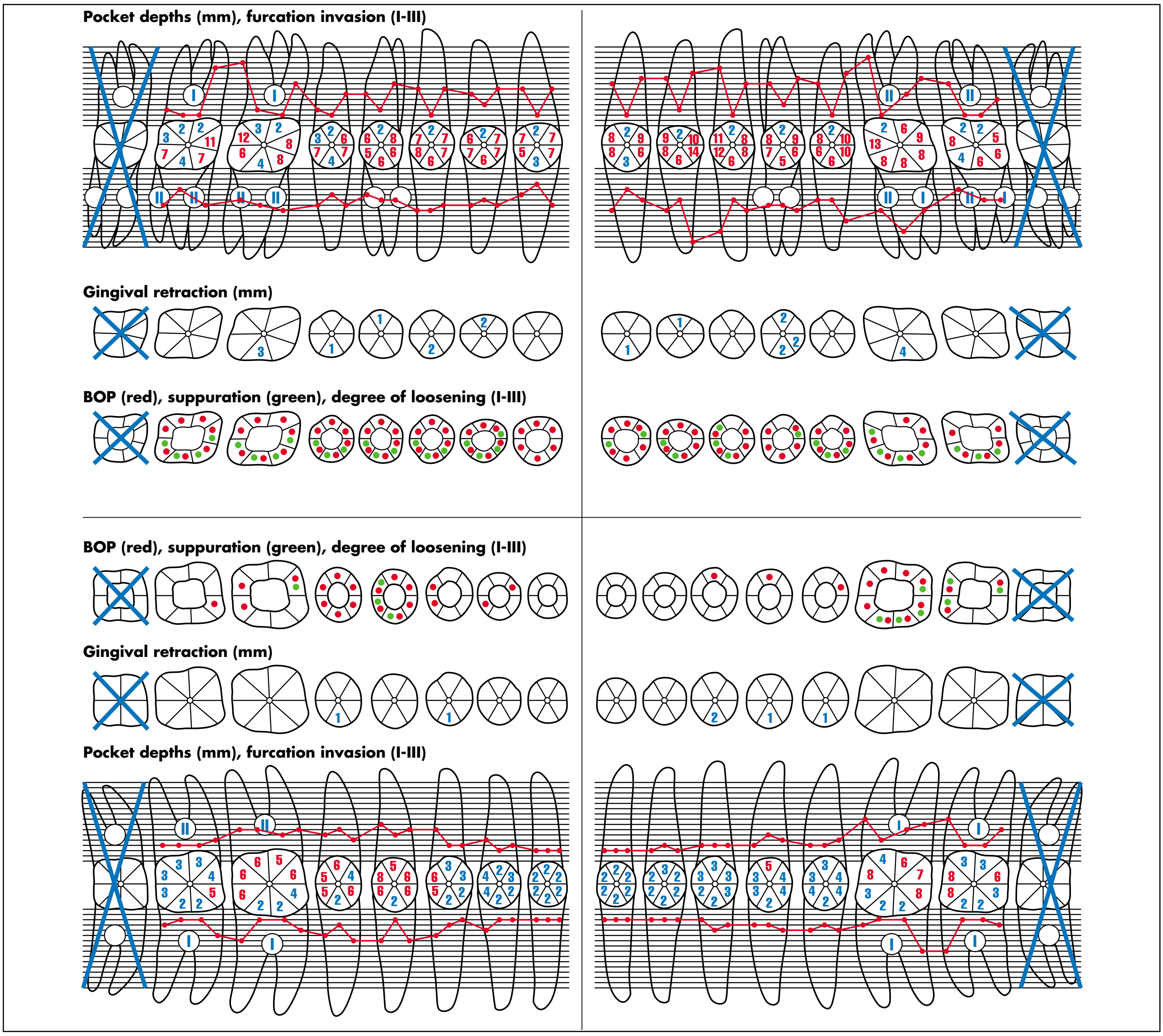


Fig. 2-18 *Clinical periodontal finding prior to treatment: massive periodontal inflammation with pronounced pocket formation and multiple pus exudation on probing.*

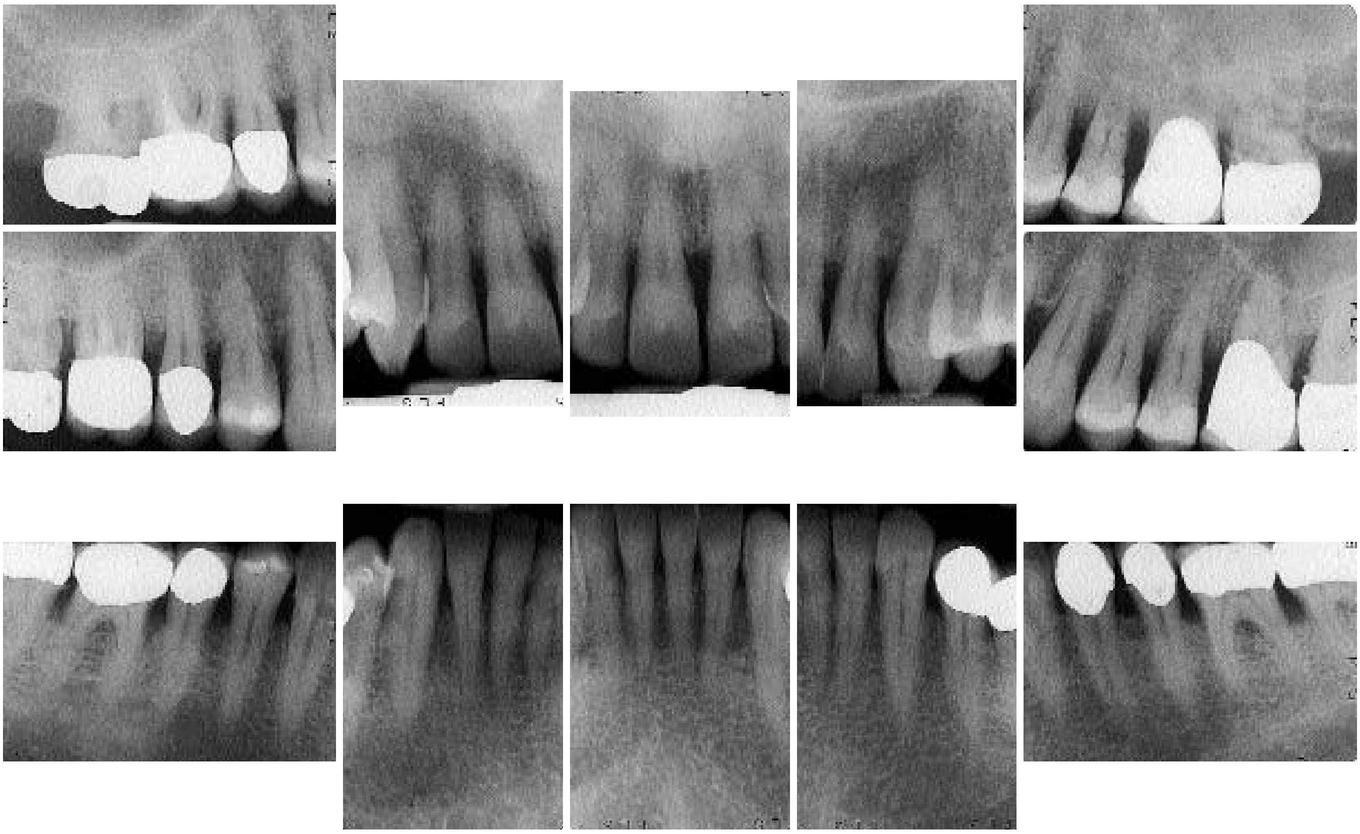


Fig. 2-19 *Radiological status: condition before treatment.*

Fig. 2-20 *Buccal views after remodelling of the existing tooth restoration before starting Vector therapy.*

Fig. 2-21 *Clinical condition 6 weeks after initial Vector therapy: labial and buccal views.*

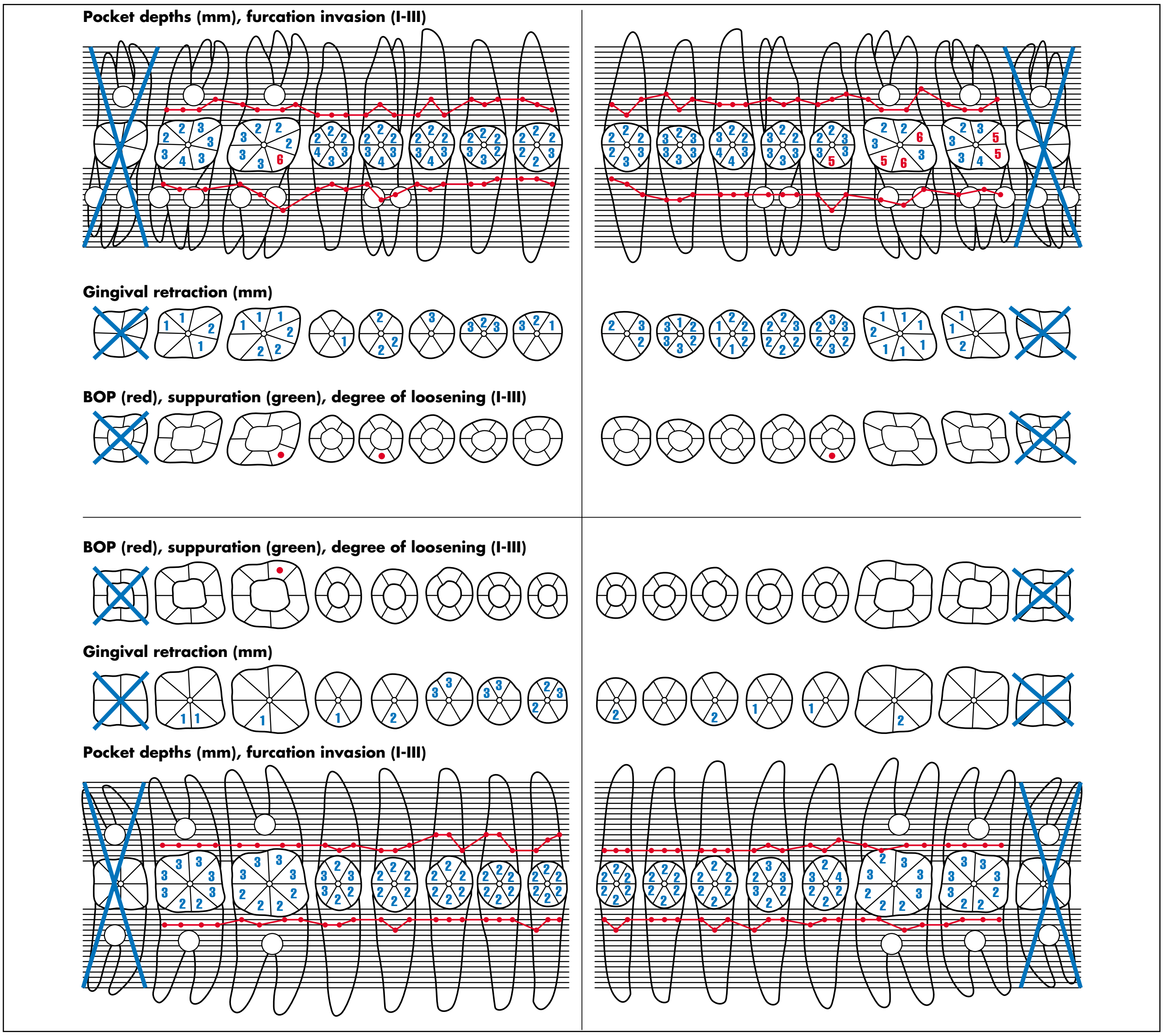


Fig. 2-22 *Clinical periodontal finding 6 weeks after periodontal treatment with the Vector system. The signs of inflammation have largely disappeared.*

Case 2: "Therapy concept"

The Vector therapy concept together with long term care of a patient with previous marginal periodontitis is illustrated by the example of a 57 year old man at the start of treatment. In summer 1997, the patient presented at our surgery with suspicion of refractory periodontitis a few days before an extraction appointment to remove various teeth in the front of the mandible and molar maxillary regions (Fig. 2-23). He requested an independent consultation concerning the treatment concept devised by his family dental surgeon. His anamnesis and family anamnesis revealed no indications of general diseases or specific risk factors. At this point in time, his teeth were inadequately cared for both from a conservative and a prosthetic aspect. Apart from the root canal treated teeth 24 and 25 with radiological suspicion of endodontic lesions and the non-sensitive situation relating to tooth 16, all teeth reacted sensitively to dry ice. The periodontal finding revealed countless deep pockets with pocket depths down to 14 mm along with a massive periodontal inflammation (locations with positive bleeding on probing) with acute lesions (locations with spontaneous pus exudation or pus exudation on probing) (Fig. 2-24). Particularly noticeable was a fistula regio 32, which using gutta percha pins in radiological diagnosis indicated a probable correlation with a periodontal origin (Fig. 2-25). The oral hygiene analysis revealed some completely blocked proximal spaces, multiple subgingival extended restoration margins with some considerable overcontouring and massive plaque deposits, particularly lingual and proximal.

After detailed instruction of the patient concerning the etiology of the disease, initial cause-based treatment and necessary supportive periodontal therapy, preliminary treatment was carried out in several sessions to achieve conditions favorable for hygiene and to eliminate endodontic lesions. In addition to the removal of restorations to teeth 24 and 25 with subsequent revision of the root canal fillings and long-term provisional care, subgingival crown margins were considerably shortened, contour overhangs remodelled by grinding and closed proximal spaces opened with diamond files. A conscious decision was taken not to carry out coarse depuration in the sense of a preliminary removal of subgingival calculus in easily accessible areas (see Section 2.6). The patient was carefully instructed in appropriate oral hygiene techniques.

A few days after the initial treatment, a closed initial periodontal treatment was carried out with the Vector method using metallic instruments and aqueous hydroxyapatite slurry (Vector fluid polish) (see Section 2.6). Disinfection additives were not used. Neither additional chemical or medicinal therapy nor the use of regeneration-supporting measures were used.

A re-evaluation of the periodontal findings was carried out six weeks after the initial treatment (Fig. 2-26). The signs of periodontal inflammation had completely disappeared apart from a few locations (Fig. 2-27). The fistula regio 32 had healed and teeth 31 and 32 appear considerably firmer. Differential diagnosis was now able to exclude critical and progressive forms of periodontitis with a high degree of probability. The underlying adult periodontitis reacted very well to the treatment without the necessity for performing a subgingival bacterial analysis or for more radical surgical treatment. The few bleeding pockets from standardized probing were checked for any remaining residual calculus or incompletely recontoured restorations and reinstrumented using instruments made of fiber composite materials during a first recall. The recall intervals were initially set at three months. The supportive periodontal treatment given during these recall sessions covered re-evaluation of the signs of periodontal inflammation (at least circular probing of all periodontia with standardized pressure against the pocket fundus and indexing of the bleeding on probing and where necessary of suppuration). Individual bleeding pockets on probing were selectively reinstrumented using the Vector method.

Fig. 2-23 *Initial clinical finding: massive gingival and periodontal inflammation with fistula regio 32.*

Fig. 2-25 *Radiological status: condition before Vector therapy. Regio 31, 32: gutta percha tips in situ to determine the origin of the fistel.*

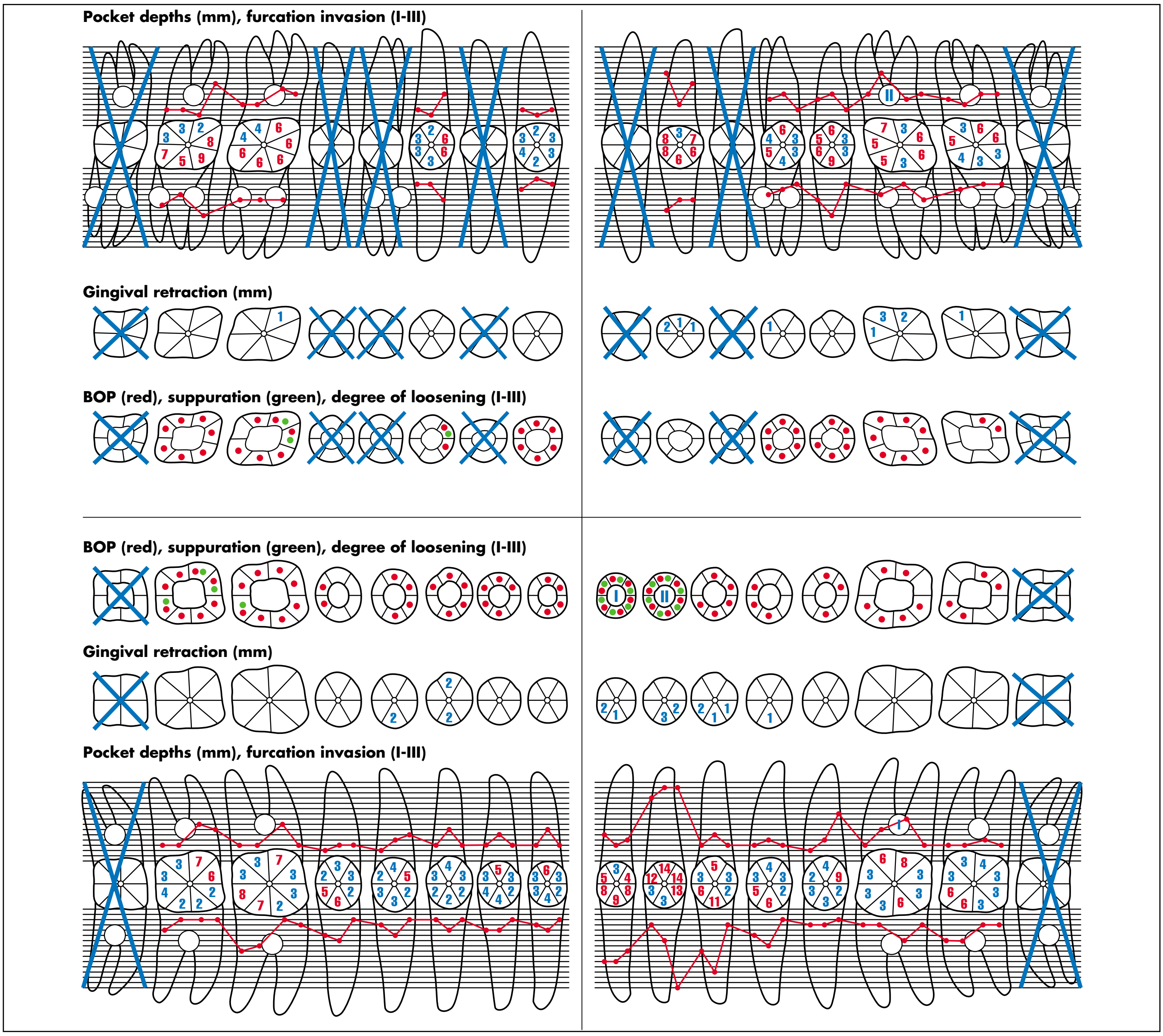


Fig. 2-24 *Clinical periodontal finding before Vector therapy: massive periodontal inflammation with pronounced pocket formation and partial pus exudation on probing.*

Fig. 2-26 *Condition 6 weeks after Vector therapy: drastic reduction in the signs of clinical inflammation. Healing of the periodontal fistula regio 32 with local residual inflammation.*

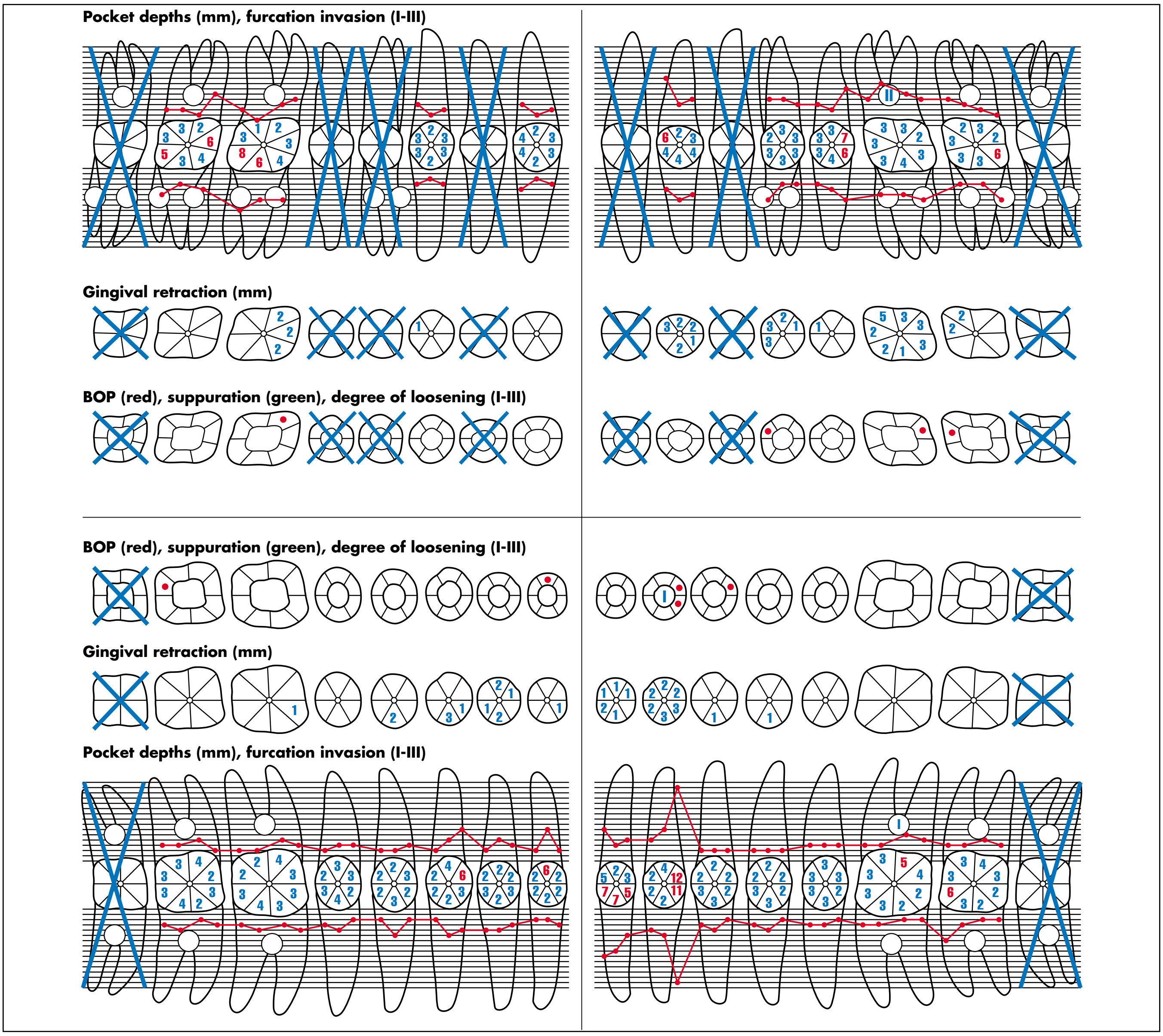


Fig. 2-27 *Clinical periodontal finding: condition 6 weeks after Vector therapy.*

__Fig. 2-28__ Condition 1 year after Vector therapy: freedom from inflammation but gingival retraction (photo before recall treatment).

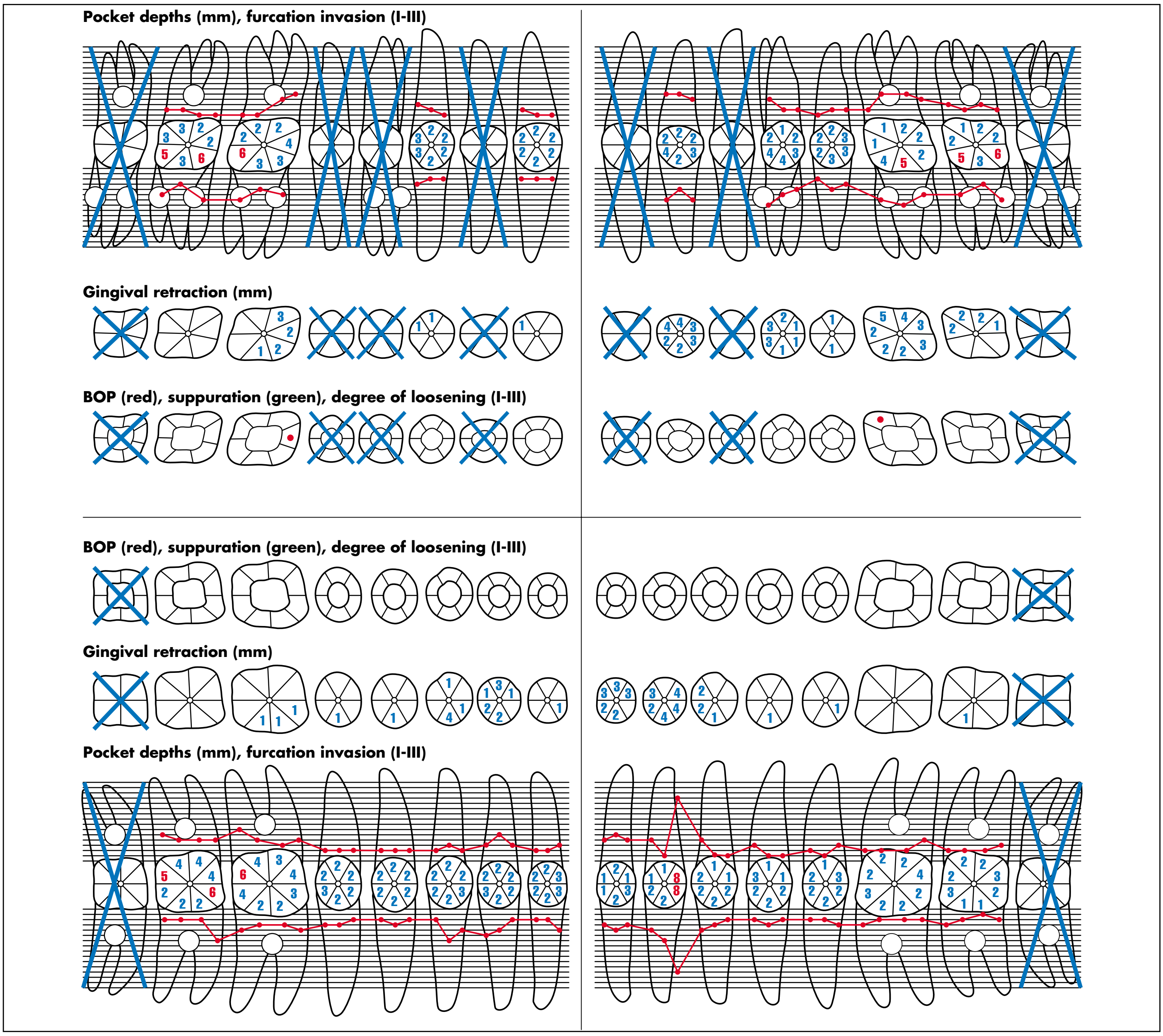


__Fig. 2-29__ Clinical periodontal finding: condition 1 year after single Vector therapy and supportive Vector periodontal therapy at 3 monthly recall intervals.

Fig. 2-30 *Condition 2 years after initial Vector therapy and after removal of the old restorations, core build-ups and preparations immediately before prosthetic rehabilitation: maxillary occlusal view (left), anterior view (middle), mandibular occlusal view (right).*

This was followed by professional teeth cleaning and fluoride treatment of all teeth. A stable, periodontal inflammation-free condition (Fig. 2-29) was able to be recorded one year after the initial treatment (Fig. 2-28). The attachment losses regio 32, 33 were hardly changed compared with the initial findings despite a considerable reduction in the correlating pocket depths and final fixing of the teeth. The patient's oral hygiene was rated as good, with small exceptions in the area of the front of the mandible. The recall intervals were thereupon extended to 6 months.

The healthy periodontal situation was also stable two years after initial treatment and with supportive periodontal therapy at six monthly intervals. A new prosthetic provision was decided and performed (Fig. 2-30). Surprisingly two years after the initial treatment, a considerable attachment gain occurred in the area of the deep intrabony pocket regio 32, 33, which was able to be confirmed by a follow-up radiograph in the sense of a bony apposition of several millimeters (Figs. 2-31, 2-32, 2-33). Apparently, nature alone was in a position to perform partial regeneration. As a result of the persisting inflammation-free situation, the recall interval was further extended to 9 months. The periodontal condition has further stabilized also after this extension of the recall interval apart from a local inflammation at 31 (Figs. 2-34, 2-35). After local treatment of this inflammation (Vector fiber composite instruments and Vector fluid polish) and after consultation with the patient, the intervals have been provisionally set at 6 months.

Fig. 2-31 *Condition 2 years after Vector therapy and prosthetic rehabilitation*

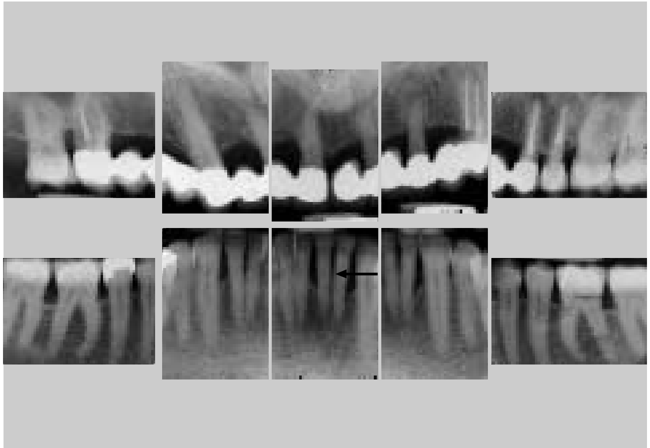


Fig. 2-33 *Radiological status two years after initial Vector therapy immediately after prosthetic rehabilitation (arrow: partial bony tissue regeneration).*

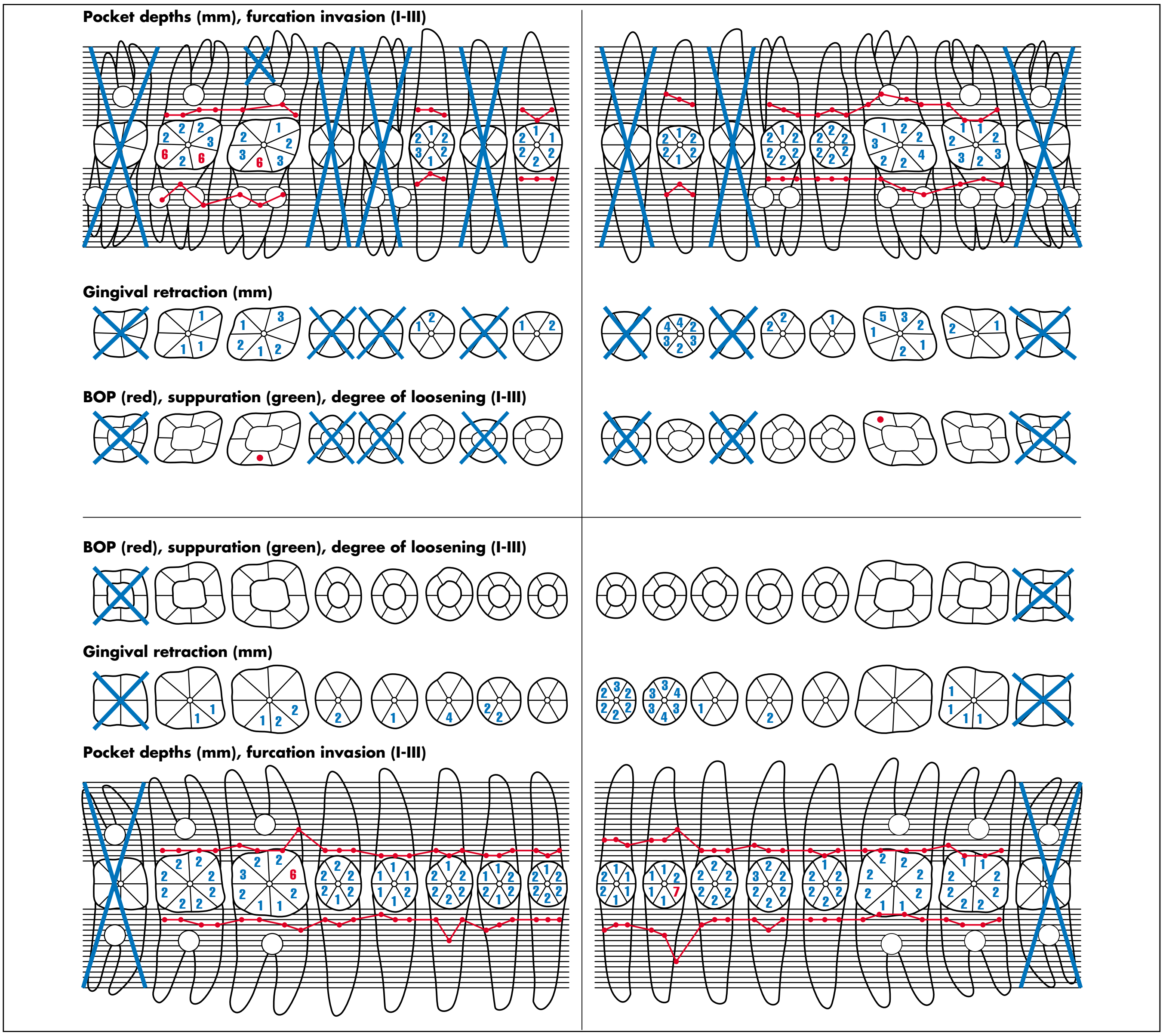


Fig. 2-32 *Clinical periodontal finding 2 years after initial Vector therapy and supportive Vector therapy at 6 monthly recall intervals*

Fig. 2-34 *Condition 2 years and 9 months after initial treatment. The final supporting periodontal therapy carried out was 9 months previously (Photo before recall).*

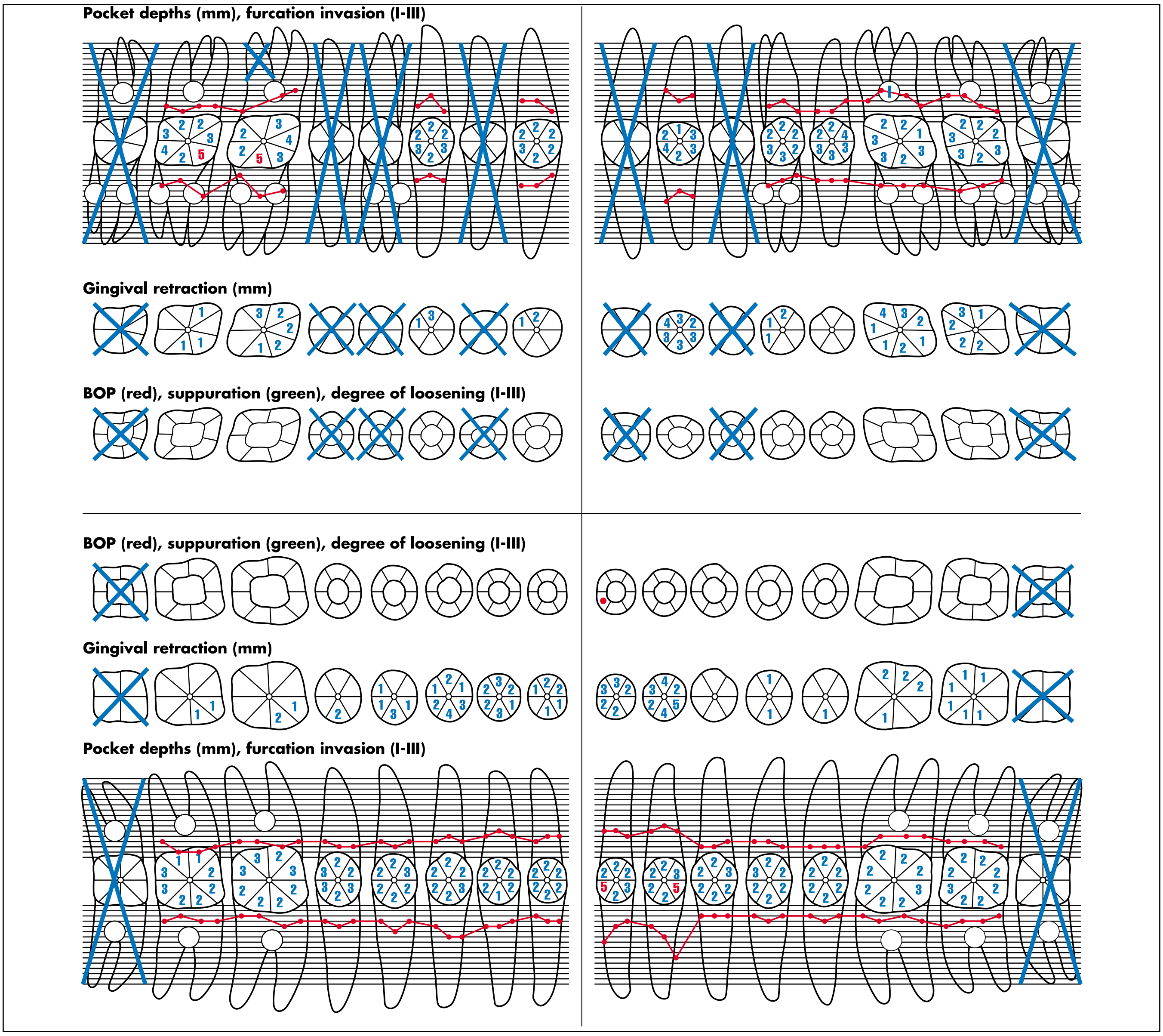


Fig. 2-35 *Clinical periodontal finding 9 months after prosthetic rehabilitation and last Vector supportive periodontal therapy (2 years and 9 months after initial Vector therapy).*

3 Aspects of periimplant mucositis and periimplantitis

The supraalveolar tissues surrounding the teeth (gingiva) and the periimplant mucosa differ in the composition of the connective tissue, the arrangement of collagen fibres, the missing cementum as well as the vessel structures in the marginal epithelium (Berglundh et al., 1991). Plaque, however, collecting on the tooth or implant surfaces (e.g., on titanium) over equivalent time intervals differs neither in mass or structure (Leonhardt et al., 1992). As with the subgingival biofilm on the tooth surfaces, the biofilm of subgingival implant surfaces is also dominated by **gram-negative bacteria**, where the microbial flora consists of up to 25 % of Porphyromonas gingivalis and Preventolla intermedia.

Persistent plaque accumulation can have the same effect on the periimplant mucosa as the gingiva, with an **inflammatory infiltrate** developing. According to Leonhardt et al. (1992), within the first three weeks no differences could be determined. Later, too, the extent of gingival destruction is similar. However, whilst the lesion around the natural tooth is restricted to the gingiva for a lengthy period and in most cases an intact barrier of connective tissue exists to the alveolar bone, the periimplant bone is affected by the inflammation early. The periimplant tissue seems to be **less resistant** against plaque-induced, inflammatory lesions than the periodontal tissue of the natural tooth. For this reason, great emphasis should be placed at an early stage on the removal of surface-adsorbed biofilms on implant surfaces and on continuous infection management. Ongoing monitoring of the periimplant mucosa and complementary measures for infection control, professional dental hygiene and instructions to the patient on oral hygiene are indispensable in the majority of cases. Patients who are suffering from periodontal disease, or have suffered from it in the past, and have had implant restorations, are particularly susceptible to periimplant mucositis or periimplantitis. In these patients the time intervals between recalls are not infrequently determined by the inflammatory relapses in the area of the periimplant mucosa.

Fig. 3 - 1 *Flexible Vector recall probe made out of a soft fibre composite material on a textured implant surface in situ (schematic representation).*

Infection management on implant surfaces is frequently made more difficult by their retentive shape (e.g., screw threads) and/or by rough surface textures. The minimally invasive design and flexibility of the Vector fibre-reinforced composite instruments recommended for treating the implant surfaces make access to the base of the pocket easier even in cases of non-linear bone loss with cavity like undercuts or intrabony pockets. The low surface hardness of the instruments and the ultrafine hydroxyapatite slurry (Vector Fluid polish) which can be used as required, guarantee reliable removal of the biofilm without damaging the surface. Furthermore, there is scarcely any mechanical trauma to the periimplant mucosa.

A major reason for the high cleaning efficiency is that the fibre composite tool partially adapts to the treated surface by selective wear during its use (Fig. 3 - 3).

The instrument's surface is thus able to come into close contact with the structured or textured surfaces, which results in more efficient energy contact through the film of liquid surrounding the tool. Handling of the instrument, the prohibition on evacuating the contact fluid at the treatment site and the pressure required are exactly the same as for treating tooth and root surfaces.

In most cases the use of fibre-reinforced composite probes on implants is sufficient both for the initial treatments and also for maintenance therapy. The sequence of treatment and the criteria for risk assessment and implementation of a consistent maintenance therapy programme correspond to supportive periodontal therapy, generally with shorter intervals of recall.

Fig. 3 - 2 *Maintenance therapy on an implant with the straight Vector recall probe after prior removal of the suprastructure.*

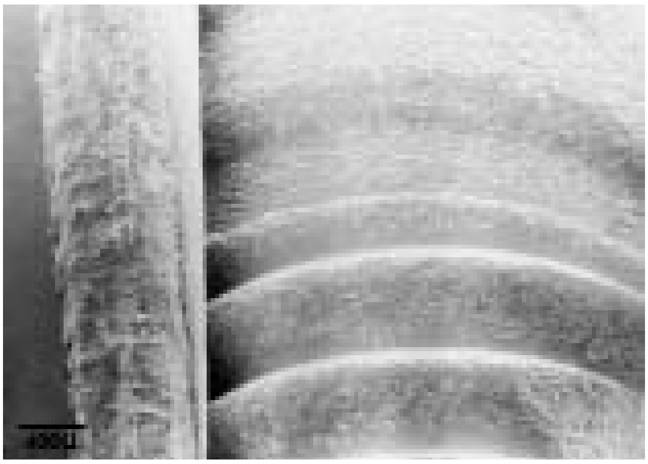


Fig. 3 - 3 *Representative scanning electron microscope image of a thread structured, textured aluminum-oxide coated titanium implant after treatment with the Vector fibre-reinforced composite probe. The implant is almost completely free of deposits and there is no evidence of surface damage. The composite probe shows the desired wear traces in the sense of a negative image of the treated surface, which increases the efficiency of cleaning.*

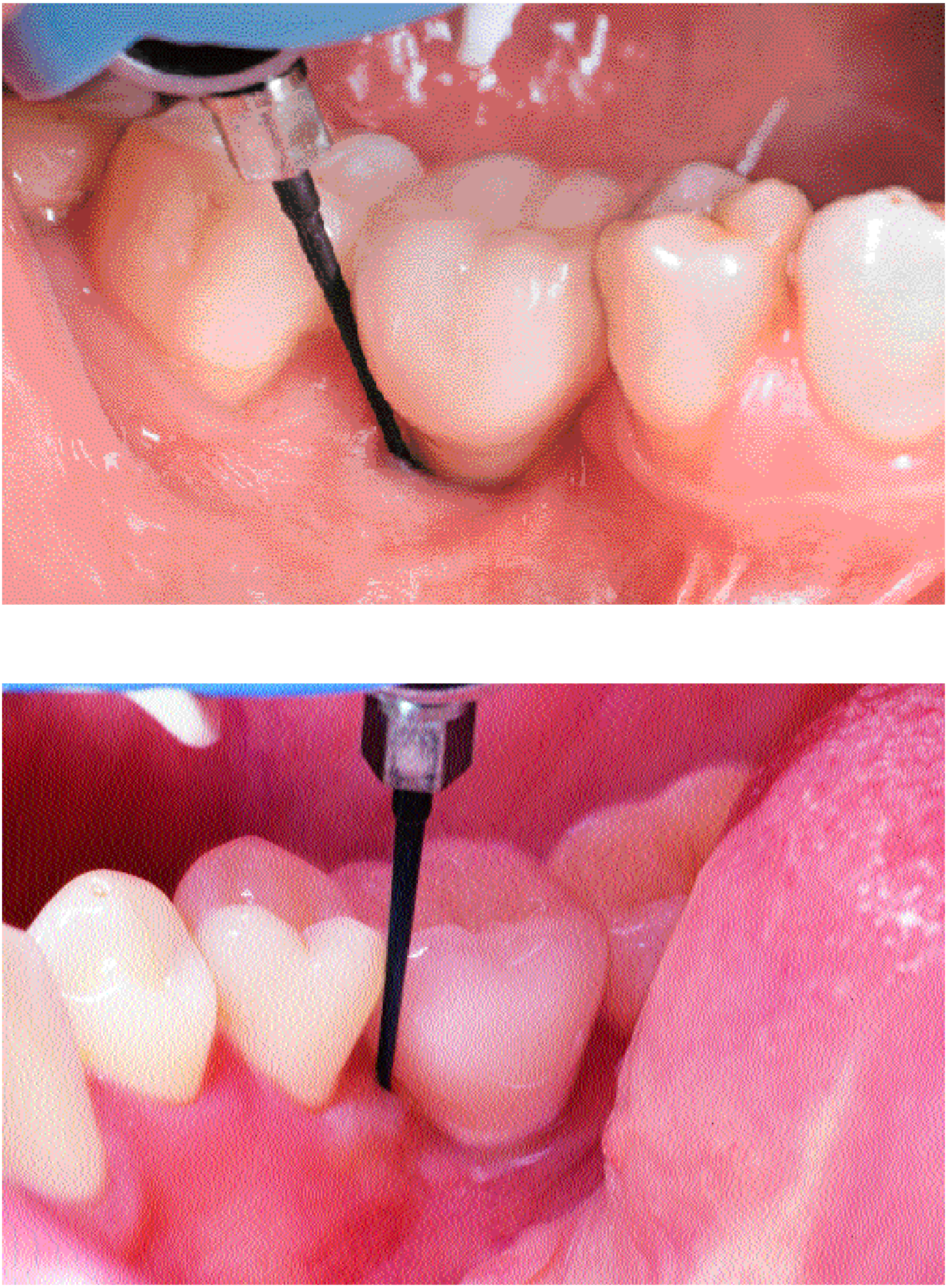


Fig. 3 - 4 *Maintenance therapy on an implant with the straight flexible Vector fibre-reinforced composite probe, without removing the all-ceramic suprastructure, in order to minimize the danger of fracturing. (top illustration: buccal view; bottom illustration: lingual view)*

4 Aspects of dental hygiene

4.1 Removal of supragingival calculus

Conventional ultrasonic instruments remove supragingival calculus deposits by blasting them off with three-dimensional vibrations of the instrument tip. The desired efficiency of the instrument is set by selecting the amplitude, which determines the degree of the mechanical micro-blasting effect. Cooling of the instrument requires large amounts of liquid, regulated according to the chosen amplitude. The resulting aerosol causes a significant risk of infection to the entire dental team. To avoid damage to the tooth surface, the vibrating instrument tip has to be guided along parallel to the tooth surface in a wiping movement. Manual rework with scalers, curettes and the use of polishing paste and rotating brushes is recommended (Björn & Lindhe, 1962).

With the Vector system, vibrating instruments, mechanical blasting and heat effects, high volumes of cooling water, severe sensitivity reactions of the patients or aerosol formation etc. are eliminated. The system works according to the principle of indirect energy contact via a film of liquid adhering to the instrument's surface. Working in a similar manner to a lithotripter, calculus is pulverized and removed due to the differing elastic moduli between tooth substrate and deposit. Therefore the mass of calculus is correlated to the time needed for the instrument to remove it. In severe cases of tough calculus formation, it may be desirable, for reasons of time, to loosen the coarse mass of deposits by using additional targeted mechanical means. The Vector method uses its own instrument for this special indication (the Vector Supra Scaler). Only this instrument has a minimal vibration characteristic in addition to the usual effects of the Vector method. The separation of the instrument from the direct ultrasonic drive, attaching it to the resonance ring typical of the Vector system, results in a considerably lower impulse transfer to the treated surfaces due to the associated significant reduction in the total vibratory mass. The risk of surface damage and the quantity of aerosol spray are considerably reduced in spite of the highly efficient cleaning effect. Using a particle suspension, for instance Vector Fluid polish or in cases with extensive calculus formation Vector fluid abrasive, increases the working efficiency of the instrument and achieves an additional polishing effect.

4.2 Removal of supragingival plaque and discolorations

In addition to the metal tools used for periodontal treatment, further dental hygiene tools made of metal are also available for the removal partly calcified plaque deposits. Soft overlaying deposits can be removed with fibre composite tools in combination with hydroxyapatite particle suspension (Vector Fluid polish). There are also various specially shaped tools available for this task. Unlike air abrasion units, all tooth surfaces can be treated with no risk of harm to soft tissues, irreversible injury to initial caries lesions or to the sensitive margins of fillings and without forced erosion of exposed dentine (Galloway & Pashley, 1987). The achievement of adequate surface smoothing and the complete removal of any stainings, in particular from microtextures, which are often seen after the application of air abrasion methods, correlates directly with the treatment time needed for this, however. By

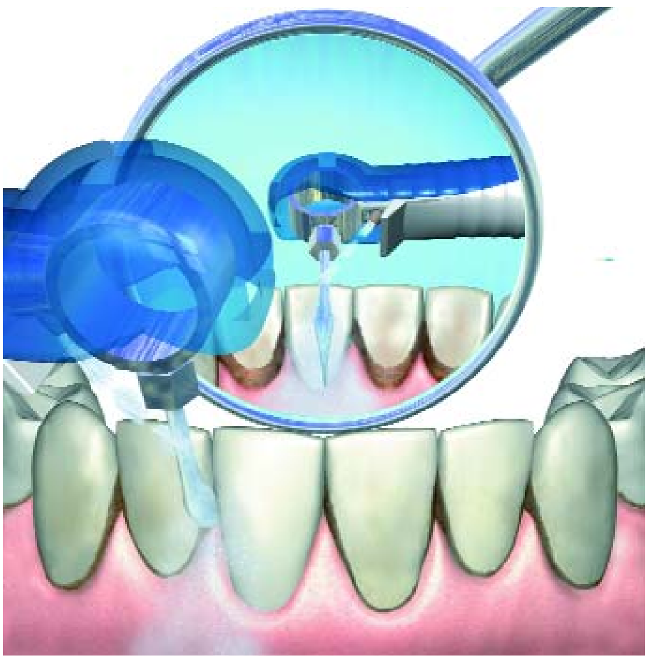
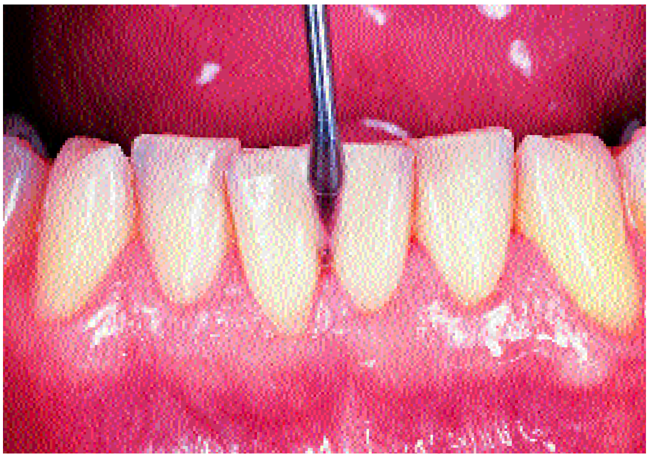


Fig. 4 - 1 *A special instrument with defined vibratory characteristics (the Vector Supra Scaler) is available for removal of solid supragingival calculus deposits (schematic representation).*

using plastic instruments containing no reinforcing fibres (the flexible Supra Probe), energy input can be minimized and the fluid dynamic effects of the system can be used selectively (for example, the flexible probe can be used as an effective irrigation aid or for the extensive polishing of tooth surfaces).



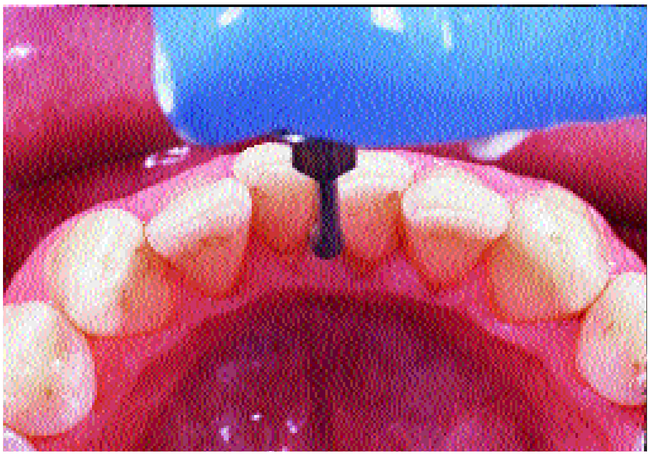
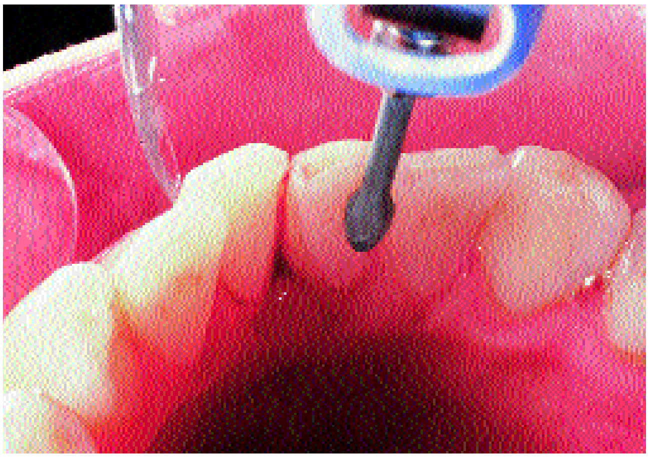


Fig. 4 - 2 *Condition after the removal of solid calculus deposits with the Vector Supra Scaler, using Vector Fluid polish. Efficient, time-saving removal of large quantities of supragingival calculus can be achieved using the minimally vibrating special instrument. The instrument is generally held at a 90-degree angle to the longitudinal ring axis. Under optimal working conditions the instrument tip, about 2 mm long and adversely curved, penetrates the sulcus opening,* ***all the contour of the tool adapting to the shape of the tooth****. When moved horizontally following the garland-shaped course of the gingiva, the instrument removes solid calculus deposits. For interdental cleaning the instrument can be physically rotated into the interdental spaces with the tip in front. Residual deposits are removed during dental hygiene with the other Vector instruments.*



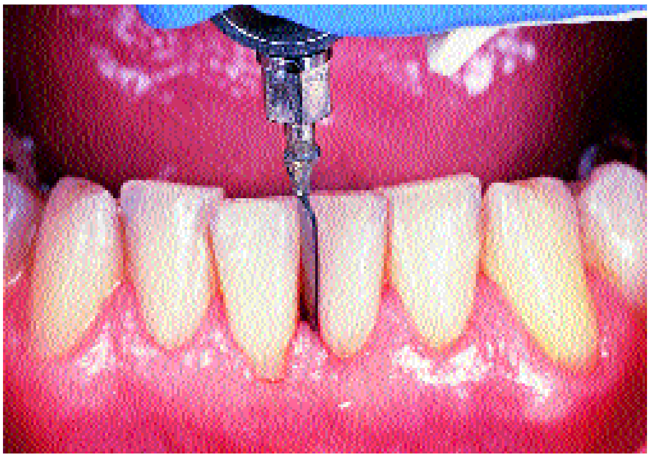


Fig. 4 - 3 *As well as periodontal treatment and recall instruments, which are also used in preference for supragingival dental hygiene, bud-shaped instruments (see illustration on the left) made of metal or fibre composite materials are available for concave surfaces (e.g., the lingual surfaces of the front teeth and the transitions in the area of the cementoenamel junction). A thin, flexible metal plate (see illustration on the right) facilitates cleaning of the interdental spaces, including the contact area and the transitions to the buccal and lingual surfaces.*

5 Aspects of microinvasive preparation of teeth or non-metal restorations

The Vector system offers specially shaped metal tools for use with an abrasive slurry of silicon carbide (Vector Fluid Abrasive) for **micro-invasive preparation, contouring and finishing** of tooth substance and non-metal restorations. In contrast to rotating tools, the Vector instruments are inserted longitudinally in a parallel manner, which allows maximum material removal. Cutting performance is reduced by horizontal preparation movements. Hollow instruments provide exact positioning and the best degree of material removal. These instruments are available in different cylindrical and oval shapes for a precise preparation. The contours of the cavity are preferably prepared with the appropriate shaping instrument, the geometry of which comprehends as large a section as possible of the cavity to be created. Under some circumstances the same or different instruments can be inserted several times in an alongside parallel way. The resultant edges on the connection points of these cavities can finally be contoured using lateral movements of the tool. For approximal cavity segments, tools that are flat on one side (e.g., hemispheres, semi-ellipses, half-flames, etc.) are available, to remove projections in the cavity edge area and to minimize the risk of damaging adjacent teeth or restorations.

The indirect energy connection via a film of liquid surrounding the instrument and the addition of a particle suspension, typical of the Vector system, are also features which characterize cavity preparation. Removal of material is effected through accelerated silicon carbide particles between the tool and the surface being prepared. These particles offer a high surface hardness and a block-shaped cutting grain geometry. The average grain size is approximately 40 - 50 µm, and is therefore analogous to fine finishing diamonds. The material removal process using loose grains is similar to a lapping process, which explains the accurate, athermal and extremely gentle nature of the process. Since heat induction has been virtually eliminated, only a small amount of liquid is needed, even for extensive preparations.

The contact pressure applied with activated instruments is the same as that used in the periodontal application. In combination with highly efficient removal a typical erosive preparation sound is created, which will soon become familiar to the user.

In order to achieve optimal cutting performance and results, the preparation instruments should be held in place continuously and moved as the cutting progresses. The high contact pressures and continuous wiping movements used with rotating diamond instruments prevent optimal energy contact. Evacuation of the fluid surrounding the instrument at the preparation site will hinder a sufficient energy contact. For this reason the amounts of excess fluid, which are in any case low, should

Fig. 5 - 1 *Microinvasive cavity preparation with Vector instruments, using an abrasive slurry (Vector Fluid abrasive). For the approximal opening, the application of a matrix band and/or separation of the approximal space is recommended for temporary protection of the adjacent teeth, even if flat instruments are used (schematic representation).*

be evacuated only at intervals, preferably in the area of the dorsal oral cavity on the contralateral side. As well as the very gentle effect on the enamel, dentine and non-metallic restoration materials in finishing mode, the reliable protection of the soft tissue close to the cavity, the avoidance of heat stress and damage to the pulp and options for the use of different shaped tools, the Vector system offers highly sensitive tactile handling for the practitioner. The high level of patient acceptance is particularly important for applications in paediatric dentistry.

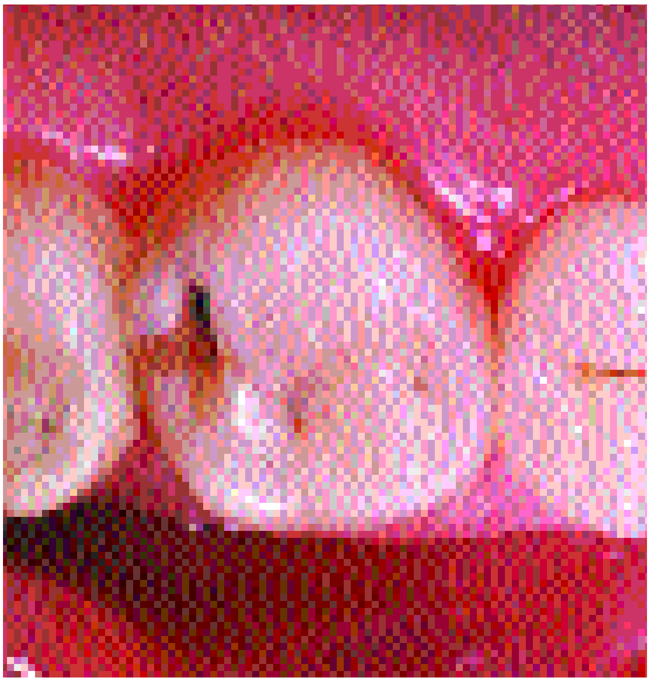


Fig. 5 - 2 *Initial caries lesions on 26 d and 27 m requiring restoration, and composite filling needing replacement on 26 o.*

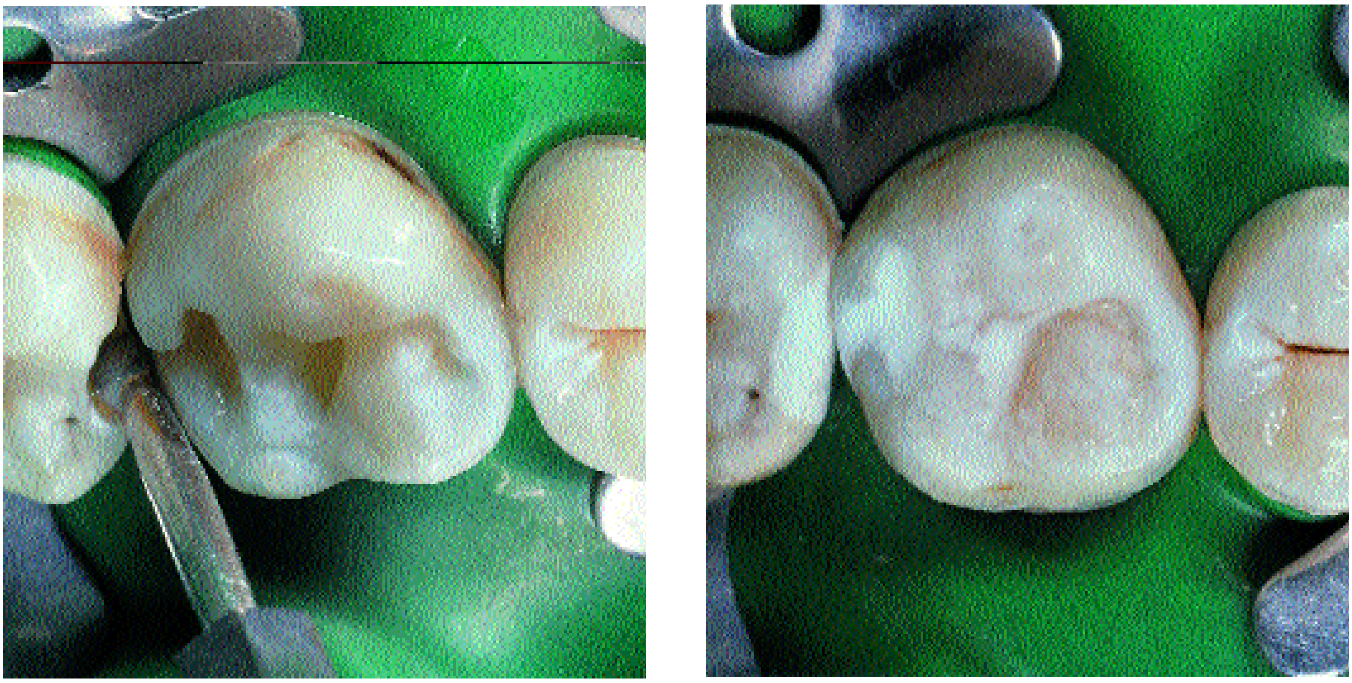


Fig. 5 - 3 *Illustration on the left: condition immediately before completion of the cavities formed according to adhesive criteria, using various shaped Vector instruments. Separate finishing of the cavities is not required.*
Illustration on the right: condition after adhesive restoration (traditional enamel and dentine etching with 37 % orthophosphoric acid, application of an enamel and dentine adhesive, matrix technique and layered application of flowable and high-filled composite using soft start polymerization). The whitish opaque coloration of the composite filling material is deliberately chosen due to the desired long-term monitoring of the marginal obturation of the fillings and for easy differentiation from intact hard substrate.

The Vector system is not suitable for the removal of soft dentine caries or to prepare metal dental restorations, except for **recontouring** small overhangs of amalgam fillings, for example. The preparation of extensive cavities or dies for prosthetic rehabilitation is not recommended either, since the Vector tools will take much longer to accomplish this than conventional high-speed diamond burs. However, the Vector system may be used to advantage to finish the margins of conventionally prepared cavities and dies, as well as to refine their final shape. No marginal flake-offs occur and no enamel prisms are dispersed (Fig. 5 - 4, 5 - 5). The same advantages apply when processing sensitive restoration margins (for example, of composite restorations or adhesive bonded ceramic reconstructions), which are especially prone to fracture immediately after polymerization of the composite due to high volume-inherent residual tension in combination with the use of rotating diamond instruments.

Fig. 5 - 4 *Representative scanning electron microscope image of an occlusal cavity prepared with the Vector system.*

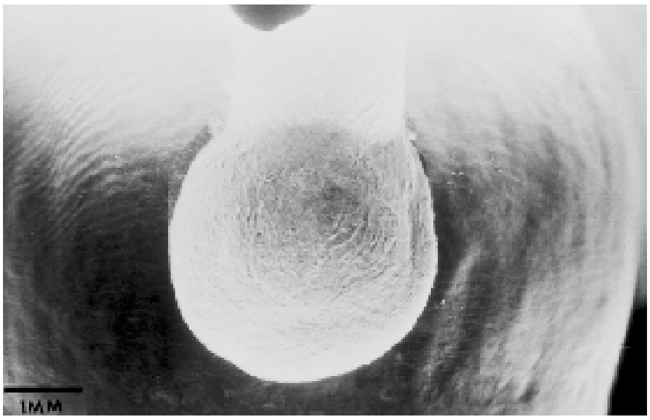


Fig. 5 - 5 *Representative scanning electron microscope image of an approximal cavity prepared according to minimally invasive criteria using Vector instruments and Vector Fluid abrasive.*

Fig. 5 - 6 *Finishing of sensitive restoration margins with metal Vector instruments in combination with abrasive or polishing particle suspensions (schematic representation).*

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