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Inflammatory, Chronic and Highly Complex

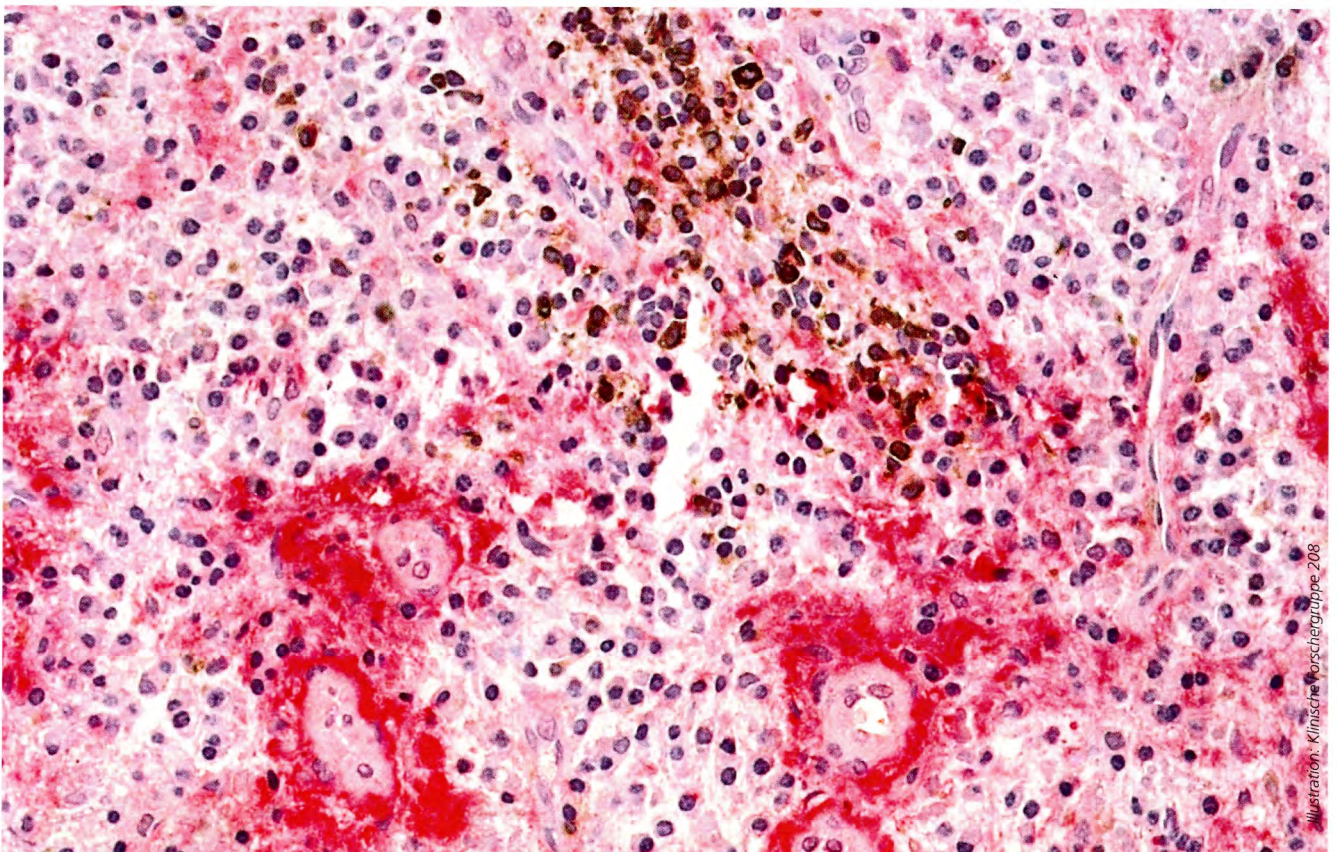
Periodontitis is a widespread disease. A better understanding of the intricate interactions between the periodontium, the oral cavity and the organism as a whole could result in more effective prevention, diagnosis and treatment of this common affliction.

Often it's not a tooth that causes a dentist concern during a check-up, but the periodontium – the tissues that surround and support the tooth. The inflammation of these tissues, known as periodontitis, is a widespread problem which, according to the latest German Oral Health Study, is becoming increasingly common. Periodontitis is a

chronic disease that leads to the destruction of the tooth-supporting tissue and is associated with gum pockets and the loosening and even loss of teeth. Periodontitis may affect a single tooth or all teeth, and may also occur in children and adolescents.

The shift in medical understanding of this disease over the

last few decades is reflected in the modern term “periodontitis” – the suffix “-itis” indicating that it is an inflammatory disease and not, as previously assumed, an age-related degenerative disease (referred to as “periodontosis”). Periodontitis is caused by certain bacteria in dental plaque. Although we know that the likelihood of periodontitis is



increased by other factors, such as smoking, heredity and certain diseases of the whole organism, there are still many research questions that remain unanswered.

The Clinical Research Unit "Aetiology and Sequelae of Periodontal Diseases – Genetic, Cell Biological and Biomechanical Aspects" is seeking to achieve a better understanding of the causes of periodontitis and therefore more effective prevention, diagnosis and treatment. One of the key questions is: Why do some patients succumb to periodontitis in spite of good oral hygiene while others remain unaffected? Everyday experience in clinical and dental practice shows that there are considerable differences in individual susceptibility to bacterial problems in the oral cavity and the way in which the organism reacts to them. These differences are partly due to our genes, but as yet we have little idea which genes are actually involved. The analysis of genetic risk factors is therefore a crucial aspect of the work of the Clinical Research Unit. Some genes or gene sequences have already been identified as risk factors for periodontitis, but the picture is still incomplete.

How does the periodontium become inflamed in the first place? Periodontitis starts when the bacteria in plaque provoke inflammation of the gum – a process involving many of the body's immune cells. These cells release inflammatory molecules and enzymes which fight the bacteria but also cause the destruction of the periodontium. As long as the inflammation remains

Affected gum with cells producing inflammatory molecules (brown).



Above: Measuring a gum pocket with a periodontal probe. Below: The bone loss resulting from periodontitis becomes visible during a gum operation.



limited to the gum (a condition known as gingivitis), all these processes are reversible. But if the processes of inflammation and destruction spread to the underlying tissue of the periodontium, the result is periodontitis. Previously it was assumed that periodontitis was caused by the reduced function of the immune cells. However, it now appears that in periodontitis patients these cells actually over-react, encouraging the destruction of the periodontium.

At present we have only a partial understanding of which immune cells are involved in the inflammation of the periodontium and exactly what role they play. Our basic research is therefore also concerned with studying inflammatory processes and the presence and localisation of special immune cells in the periodontium in affected patients. The study of inflammation has shown that cells release a multitude of antibacterial molecules in order to fight a



In the X-ray on the left, bone loss is clearly visible. The image on the right shows partial regeneration ten months after special periodontitis treatment. Below right: Regular check-ups are essential for periodontitis patients.

bacterial infection. However, more detailed research is still required to establish the extent to which these antibacterial substances are produced by the cells of the periodontium itself and whether they could be used in diagnosis, risk assessment and treatment for periodontitis. Research carried out to date suggests that cells in the periodontium produce various antibacterial molecules when stimulated by periodontitis bacteria, and that these molecules can in turn influence cell behaviour – a complex set of interactions.

Whenever the patient chews or brushes the teeth, bacteria from the periodontium enter the bloodstream. The more ad-

vanced the periodontitis, the more bacteria there are. These bacteria and their components can then directly damage the cells of the blood vessel walls or stimulate immune cells in the blood to secrete inflammatory molecules. As a result, the concentration of inflammatory molecules in the blood rises. The circulation then carries these inflammatory molecules to all parts of the body, where they may again change blood vessel cells and also inhibit glucose uptake in the body's cells. We can see, then, why periodontitis increases the risk of cardiovascular disease and can cause the onset or worsening of diabetes.

The negative effects of periodontitis are also illustrated by the

fact that treatment for periodontitis can improve vascular function and reduce blood sugar levels in people with diabetes. Conversely, diseases of the whole organism can promote the onset and progression of periodontitis. There are still many unanswered questions as to the causes of the various interactions involved in this disease. For example, we want to find out what effect periodontitis has on the regenerative capacity of vascular wall cells and, conversely, the extent to which the restoration of blood vessel function can result in improvements in the periodontal tissue.

Experiments to date suggest that when periodontitis is present, fewer “replacement cells”

are produced by the bone marrow, significantly reducing the regenerative ability of a damaged vascular wall. Periodontitis is also associated with oral tumours. An interdisciplinary project is currently underway to find out what mechanisms could be responsible for this.

If periodontitis is left untreated the destruction of the periodontium may progress unimpeded, eventually resulting in the loss of teeth. However, periodontitis can now be successfully treated. The main aim of treatment is to reduce or eliminate periodontitis bacteria in gum pockets using special instruments and procedures. In some cases, surgical intervention or the use of antibiotics may be necessary. Treatment can halt or slow further destruction of the periodontium,

although it is not usually possible to rebuild lost tissue. However, with the help of modern treatment methods, regeneration of the periodontal tissue is sometimes achievable – although it is currently very difficult to predict the results of regenerative treatment. A range of factors may be responsible for this, for example bacterial infection, inflammation, excessive loading to the teeth or disease of the organism as a whole.

The Clinical Research Unit is therefore examining the question of how periodontal regeneration can be supported and what conditions might be conducive to or indeed optimal for this process. Studies indicate that various growth factors, parathormone and enamel matrix proteins have the potential to support regeneration of the periodontium. However, inflammatory processes, heavy chewing and molecules from fat tissue can all inhibit this regeneration-promoting effect. The age of the patient also influences the success of the treatment. The awaited results should help to improve periodontal regeneration and make it easier to predict the outcome.

One question that has already been mentioned is whether and how the level of use of the teeth, for example through chewing, contributes to periodontitis. Computer models are used to simulate different conditions in the periodontium to predict how increased chewing, for example, affects the progress of the disease. A factor closely linked to periodontitis and chewing force is tooth mobility. Researchers are therefore trying to develop a special apparatus to measure this factor. It is hoped that the careful measurement and re-

cording of changed tooth mobility will improve accuracy of prognosis and treatment planning for patients with periodontal disease.

It is clear that periodontitis is a highly complex disease and research for the purposes of prevention, diagnosis and treatment of periodontal disease is and must be equally complex. Interdisciplinary collaboration outside the limits of dental medicine is essential to the development of new treatment concepts and the reduction of health risks to the whole human organism.



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