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We bid farewell



“Dr. Peter Geistlich impressed me.”

I had intended to say a few words on the new design of GEISTLICH NEWS; however, with the passing of Dr. Peter Geistlich, this editorial is dedicated to him.

Dear readers, with this GEISTLICH NEWS we bid farewell to a far-sighted entrepreneur, a passionate scientist and a unique man. When I first met Dr. Peter Geistlich 28 years ago, he impressed me with his charisma and enthusiasm. A man stood before me who knew what he wanted. His open-mindedness, his determination but also magnanimity toward the concerns of his employees made him a father figure and entrepreneur in equal measure. In a nutshell: he will be greatly missed.

Dear readers, also read the obituary by Dr. Andreas Geistlich on page 30, and join us in bidding farewell.

A handwritten signature in black ink, consisting of a horizontal line followed by a stylized, cursive-like flourish.

Paul Note
CEO, Geistlich Pharma AG

PERI-IMPLANTITIS – A PROBLEM.

Infections around implants are stubborn. What can help?
What doesn't? How can infections be prevented?



How prevalent is peri-implant disease?



Prof. Niklaus P. Lang | Switzerland

Emeritus Professor at the University of Bern /
Honorary Prof. at the University of Hong Kong /
Honorary Prof. at the University of Zurich /
University College London

Peri-implantitis is such a recent phenomenon that there is still virtually no dependable data on the prevalence of the infection. Estimates put its incidence at around 1% per year.

The question of how frequently peri-implant disease crops up is not easy to answer. To begin with, there is a lack of specially designed epidemiological studies on the topic. As a result we can only infer the number from retrospective cohort studies. Next, studies define peri-implantitis differently, so results cannot always be compared between studies. Third, the frequency of peri-implantitis in a patient group is subject to diverse factors; therefore, the frequency differs by patient group.

Diverse definitions – varying prevalence

The definition of peri-implantitis, of course, plays a crucial role in calculating the prevalence and incidence. Peri-implantitis is such a recent medical

condition that it was rarely treated as a biological complication in studies published prior to 2000. Soft tissue lesions were specified in a small number of cases, but not defined, or peri-implantitis was defined according to a few arbitrary radiological bone heights, which were made public after a conference in 1986¹. Therefore, data originating from earlier studies frequently cannot be used to ascertain the prevalence of peri-implant disease. In addition to bone loss, there is now also probing pocket depth (PPD) as a relevant clinical parameter, especially when the goal is to diagnose peri-implantitis at an early stage². An increasing probing pocket depth is very likely the first indication of the onset of peri-implantitis and suggests the need for a radiographic examination of the state of the bone.

Different studies have defined different probing pocket depth thresholds for diagnosing peri-implantitis. As a rule, a probing pocket depth of ≥ 5 mm has been taken as a basis for an early indication or Stage 1 peri-implantitis, and a probing pocket depth of ≥ 6 mm for more advanced peri-implantitis (Stage 2).

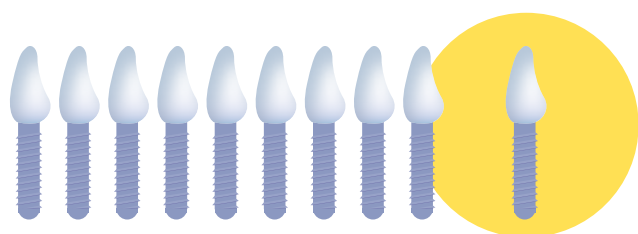
Different thresholds for the probing pocket depth inevitably change the recorded prevalence of the disease. For example, in a contemporary study³

involving a group of 70 patients with treated periodontitis and with implants averaging eight years, it was observed that 22.2% of the implants were affected by Stage 1 peri-implantitis (PPD ≥ 5 mm) in a high percentage of the patients (38.6%). If the peri-implantitis threshold had been set at a probing pocket depth of ≥ 6 mm (Stage 2), the peri-implantitis prevalence would have decreased to 8.8% in 17.1% of the patients.

In corollary, this means that peri-implantitis affecting one in twelve implants was diagnosed in one in six patients after an eight year “incubation period”.

Prevalence subject to patient group

Prof. Giovanni Salvi, Switzerland, has listed the risk factors for peri-implantitis in his article (p. 9–11). The presence of these risk factors – e.g., smoking, previous periodontitis, hard-to-clean reconstructions and cement residue from implant-supported crowns – also affects the prevalence of peri-implantitis in a patient group. As an example, residual cement from implant-supported crowns initiated peri-implantitis in 85% of patients prone to periodontitis, whereas prevalence was



On average peri-implantitis occurs around every tenth implant and in every fifth patient after a five to ten year period.

Illustration: ©iStock.com/dem10

only 1.08 % in control patients with screw-retained crowns⁴. On the other hand, after removal of residual cement, fiber-optic magnification revealed no further peri-implantitis in 74 % of patients⁵.

Peri-implant disease correlates strongly with patient susceptibility to periodontal disease^{6–8}. Prevalence in susceptible patients can be influenced by residual periodontal pockets following active periodontal treatment³ or untreated periodontal pockets.

Systematic review of prevalence

For the 3rd EAO Consensus Conference in Pfäffikon, Switzerland – February 2012, a systematic review was undertaken to determine peri-implantitis prevalence and incidence.⁹

As the studies included in the analysis were heterogeneous, no meta-analysis could be performed, and no unequivocal, exact and relevant proportion of implants could be

calculated following a specific peri-implant disease “incubation period.” The analysis therefore concentrated on describing all the relevant studies, and it was estimated that “five to ten years after implantation, approximately 10 % of the implants and 20 % of the patients were affected by peri-implantitis.”

It needs to be taken into account, however, that this cumulative prevalence of about 1% per year of “incubation” is a very rough estimate subject to the above-mentioned “patient specific” risk factors.

Estimation of the incidence

To calculate the assumed incidence of peri-implantitis would necessitate accurately defining an additional peri-implantitis symptom – most likely the loss of bone of ≥ 2 mm within a specific time period. From the prevalence we can only speculate that the incidence of new cases of peri-implantitis is around 1% per year.

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Peri-implantitis and periodontitis differ



Prof. Tord Berglund | Sweden
The Sahlgrenska Academy at
University of Gothenburg | Göteborg/Sweden

Infections around teeth and infections around implants have aspects in common. But in comparison with periodontitis, peri-implantitis exhibits various characteristics that make treatment more difficult.

Consensus reports from European Workshops on Periodontology have stated that peri-implant mucositis and peri-implantitis are infectious diseases. Peri-implant mucositis describes an inflammatory lesion that resides in the mucosa, whereas peri-implantitis also affects the supporting bone¹. In addition, peri-implantitis is characterized by changes in the height of the crestal bone in conjunction with bleeding on probing, with or without concomitant deepening of peri-implant pockets. Pus is a common finding in peri-implantitis sites².

Mucositis vs. Gingivitis

Results from clinical and experimental studies have revealed that peri-implant

mucositis and gingivitis have many features in common. Gingivitis and peri-implant mucositis lesions form in gingival and peri-implant connective tissues in response to plaque formation on teeth or implants and are similar in terms of locations, size and composition³. Gingivitis and peri-implant mucositis lesions, if left untreated, may progress, become destructive and develop into periodontitis and peri-implantitis lesions, respectively.

More neutrophil granulocytes and osteoclasts

Although there are obvious similarities regarding clinical characteristics and the etiology of peri-implantitis and periodontitis, the two lesions have critical histopathological differences between them. Data from experimental studies and the analysis of human biopsy material have demonstrated that peri-implantitis lesions are poorly encapsulated and extend to the bone. They are larger and extend closer to the bone crest than periodontitis lesions. In addition, peri-implantitis lesions contain larger proportions of neutrophil granulocytes and osteoclasts than periodontitis lesions⁴⁻⁶.

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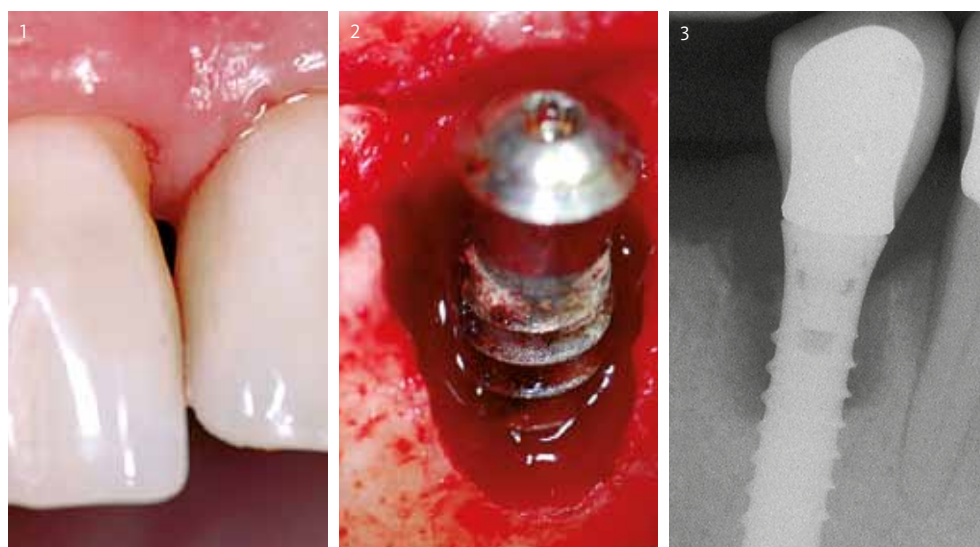
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Timely peri-implantitis diagnosis



Prof. Giovanni E. Salvi | Switzerland

Dep. Director, Clinic for Periodontology,
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Bern/Switzerland



- 1 Bleeding on probing indicates pre-existing peri-implant mucositis, which, if left untreated, can develop into peri-implantitis.
- 2 The surgical depiction shows a typical crater-shaped, bone defect.
- 3 Peri-implant defect radiograph.

Photos: Salvi

In recalls following implant placement, the peri-implant tissue should undergo careful clinical and radiological monitoring so that changes will be promptly noted.

Implant probing plays a key role in diagnosing peri-implant disease, as does a radiological check, in which bone changes should be compared with baseline radiographs from the time of reconstruction.

Probing peri-implant soft tissue

A periodontal probe made of plastic or metal should be used to explore four to six sites around the implant. No probing should be done while the soft tissues are healing following implantation (6–8 weeks). The probing pocket depth should be compared with the baseline following reconstruction. The probing pressure should not exceed 0.2–0.25 N. An increasing probing pocket depth is an alarm requiring further investigation.

In the case of implants that are set deeply in the aesthetic zone, 5–6 mm

probing depths are possible in the approximal region, even in non-inflamed conditions.

Signs of inflammation and bleeding in response to probing

Clinical changes in the peri-implant mucosa, such as reddening and swelling, should be examined regularly. The absence of bleeding in response to probing is an indication of peri-implant health.

A two-year observation period has shown that peri-implantitis progresses

if bleeding on probing occurs in more than half of the follow-up sessions¹.

Radiographic images

The radiographic depiction of the implant should always be linked to the clinical diagnosis. Intraoral dental imaging, orthopantomography (OPT) and, for special indications, digital volume tomography have been shown to be successful in radiographic diagnosis. The distance should be measured from a fixed reference point, for example the implant shoulder, to the crestal bone. The bone level at the time of reconstruction serves as a radiological reference (baseline).

Implant mobility

Implant mobility is an indication of a complete loss of osseointegration, and therefore cannot be used for early diagnosis of peri-implantitis. Implant mobility, when there are no signs of bleeding on probing, increased probing pocket depths, suppuration or crestal bone loss, can indicate improper loading².

Suppuration

A purulent secretion with or without formation of fistulae is the consequence of advanced inflammation. Suppuration is therefore also not suited for early diagnosis of peri-implantitis.

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PERIO CASE HISTORY

The survival and success rates of implants in patients with previously recorded periodontitis are lower than in patients without periodontal issues³.

Conclusion: a check for periodontal infection prior to implantation is highly recommended. Leaving residual pockets > 5 mm with bleeding on probing jeopardizes implant success rate^{4,5}.

SURFACE ROUGHNESS

Implants with a smooth or micro-rough surface show a comparable incidence of peri-implantitis over a 13-year observation period¹⁷.

MUCOSITIS

Diagnosed and untreated mucositis is more likely to develop into peri-implantitis than treated mucositis¹⁶.

Conclusion: treat mucositis promptly.

Risk factors for peri-implantitis

Prof. Giovanni E. Salvi | Switzerland

SUPPORT

The 10-year survival and success rates of implants in patients with treated periodontitis are worse with irregular hygiene⁶.

Conclusion: a regular 3–6 month recall interval tailored to a patient's risk profile is recommended⁷.

SMOKING

Smoking causes soft tissue complications and elevated peri-implant bone or implant loss⁸⁻⁹.

Conclusion: a smoking cessation program boosts implant survival rate¹⁰.

CLEANING OPTION

Poor access reconstructions exhibit increased peri-implantitis compared with good access¹¹.

Conclusion: A well-integrated reconstruction should provide unimpeded cleaning access.

ORAL HYGIENE

Poor oral hygiene raises the risk for peri-implantitis¹².

Conclusion: optimum oral hygiene is key to maintaining inflammation-free, peri-implant health.

CEMENT RESIDUE

Iatrogenic cement residue is linked to mucositis and peri-implantitis¹³.

Conclusion: a great deal of attention should be paid to cementing; otherwise, a screw-retained reconstruction is preferable.

IMPLANT STRAIN

Despite animal experiments failing to detect strain as a cause for osseointegration loss¹⁴, without evidence of infection, osseointegration loss cannot be ruled out in humans².

KERATINIZED GINGIVA

Insufficiently wide (<2 mm) keratinized gingiva is linked with elevated plaque accumulation, inflammation and recession¹⁵.

Conclusion: care should be taken during implantation and reopening to ensure that the keratinized gingiva is sufficient (≥ 2 mm).



Treating peri-implantitis systematically



Prof. Lisa J. A. Heitz-Mayfield | Australia
The University of Western Australia
The University of Sydney
West Perth Periodontics

There is no single measure for resolving peri-implantitis but rather a sequence of steps: First, causative actors should be identified and resolved, then infection around the implant should be managed and, finally, regeneration of the defect can be considered.

Step 1 – Assessing the situation

The implant-supported prosthesis should be evaluated to determine if there are any causative factors such as screw-loosening, excess luting cement, poor abutment fit or poor prosthesis contour. The prosthesis should also fit well and provide access for easy cleaning. Corrections should be made where necessary (this may involve removal of the prosthesis). Risk factors, including poor oral hygiene, smoking, diabetes or the presence of deep periodontal pockets, should also be addressed¹.

Step 2 – Non-surgical debridement

Non-surgical debridement using appropriate instruments, such as titanium curettes, air-powder abrasive devices, ultrasonic devices, photodynamic therapy, or Er:YAG laser, should precede surgical intervention. Systemic antibiotics, local antimicrobials and/or the use of topical antiseptics (e.g., chlorhexidine) may be concomitantly prescribed. Individual oral hygiene instruction should be provided to ensure good plaque control.

Step 3 – Re-assessment

A re-evaluation should be made approximately 4-weeks after non-surgical debridement to determine if there has been a resolution of peri-implantitis. Some cases of peri-implantitis will resolve following non-surgical management, in which case patients can commence at home maintenance care.

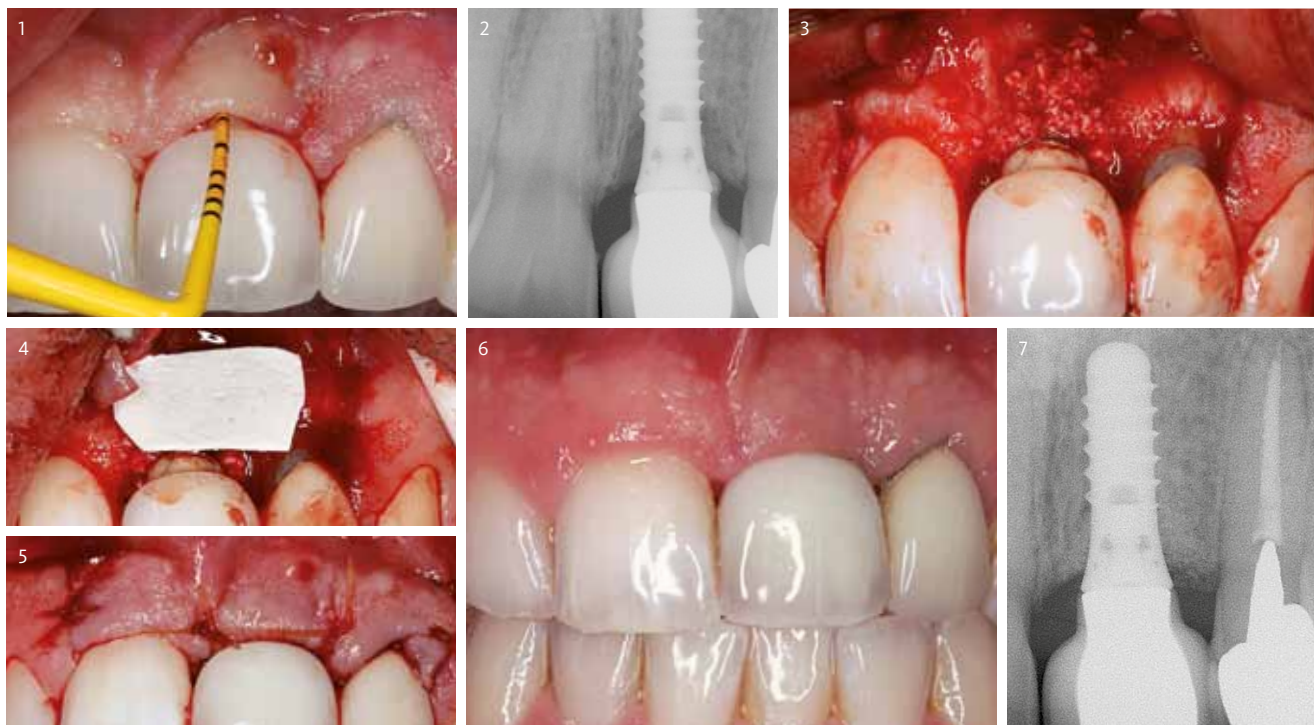
Step 4 – Surgical intervention

If the peri-implantitis has not resolved at re-evaluation, a surgical approach is

recommended. Surgical intervention is frequently required when the peri-implantitis lesion is severe with advanced bone loss and deep Peri-implant pockets. The presence of retained excess luting cement located submucosally usually requires a surgical access approach for cement removal. Surgical management involves elevating a full mucoperiosteal flap and removing the inflammatory granulation tissue to allow thorough decontamination of the implant surface. Various implant surface decontamination methods have been investigated including: rubbing with gauze soaked in saline, chemical agents such as citric acid or hydrogen peroxide, mechanical cleaning with a curette or a titanium brush, laser treatment and air-powder abrasive devices. However, currently there is no one decontamination method that has proved to be superior.

Access flap approach

In the access flap approach, no attempt is made to regenerate the bone. Following thorough implant surface decontamination, the flap is closed and allowed to heal. Soft-tissue recession is frequently observed as a part of the healing process, but the main goal of this treatment approach is to resolve inflammation².



Photos: Heitz-Mayfield

Resective approach

In some situations where aesthetic outcomes do not have high priority, the bone peaks around the implant can be removed or reshaped to allow the flap margins to be positioned apically. After healing, this technique results in a reduction in peri-implant pockets but also significant soft-tissue recession. Implantoplasty, i.e., modification of the implant surface using a carbide or diamond bur, has also been described in conjunction with this treatment modality. The aim of implantoplasty is to modify the implant surface to facilitate oral hygiene following healing.

Regenerative approach

Another treatment approach aimed at regeneration and re-osseointegration of the peri-implant bone involves filling the intrabony component of the defect with a bone graft or bone substitute material followed by coverage with a barrier membrane (Fig. 1). Contained intrabony defects are more suited to a regenerative approach than

non-contained defects, where there are no residual bony walls to support the graft material.

In an attempt to regenerate the peri-implant defect, numerous graft materials have been studied, including autogenous bone, allogeneic decalcified freeze-dried bone, phytogetic calcium carbonate, hydroxyapatite, tricalcium phosphate or xenogeneic bone mineral. In some protocols, non-resorbable membranes of expanded polytetrafluoroethylene (e-PTFE), resorbable synthetic or collagen membranes have been used to cover the graft material.

Varying amounts of defect fill have been reported. Animal studies have shown that re-osseointegration of a previously contaminated implant surface is possible following a regenerative approach. Several studies have shown that regenerative approaches can provide successful long-term treatment outcomes in the majority of patients³⁻⁶.



- 1 Peri-implantitis at implant site 21 with deep probing depths, a draining sinus on the buccal mucosa and bleeding and suppuration following probing.
- 2 Periapical radiograph showing marginal bone loss and the presence of excess luting cement.
- 3 After flap elevation, removal of the excess cement and decontamination of the implant surface, the intrabony defect is filled with Geistlich Bio-Oss® graft material.
- 4 The Geistlich Bio-Oss® is covered with a resorbable collagen membrane (Geistlich Bio-Gide®).
- 5 Immediately after flap closure and suturing.
- 6 Clinical photograph 12-months after healing.
- 7 Periapical radiograph 12-months after treatment.
- 8 Materials used for a regenerative treatment approach: Geistlich Bio-Oss® and Geistlich Bio-Gide®

Step 5 – Post-surgical care

During the immediate post-operative healing phase, daily rinsing with chlorhexidine is recommended to provide adequate biofilm control. Although there are currently no randomized controlled trials evaluating the effect of systemic antimicrobials for peri-implantitis, peri-operative systemic antimicrobials are commonly prescribed to suppress the microbial load, particularly with specific periodontal/peri-implant pathogens. The possible side effects of systemic antimicrobials should be discussed with the patient prior to administration.

Step 6 – Maintenance care

The final treatment phase involves the provision of an individualized maintenance care program. Regular monitoring, oral hygiene reinforcement and professional supra-mucosal biofilm removal is required to avoid reinfection or the recurrence of peri-implantitis.

The frequency of maintenance depends on the risk assessment for each patient. Relevant factors include

smoking habits, periodontal status, diabetes and oral hygiene.

Removal of implants

When peri-implantitis treatment is unsuccessful, or when there is a severely compromised aesthetic result, removal of the implant may be required. The implant should be removed in a conservative manner, avoiding damage to neighbouring structures and preserving as much bone as possible.

Many implant manufacturers have a specific tool that can be used to remove their particular implant by reversing it at high torque. Following removal of the implant, augmentation of the site using a bone graft or bone substitute material in conjunction with a barrier membrane may be considered for regenerating the site.

Conclusions

A recent systematic review concluded that in most studies peri-implantitis treatment resulted in an improvement

in clinical conditions for the majority of patients. However, in some patients, despite treatment, there was a recurrence or progression of disease requiring re-treatment or removal of the implant⁷.

It is important to note that it is the anti-infective treatment protocol in its entirety that contributes to a successful treatment outcome. With respect to the choice of treatment modality, the clinician should choose the most appropriate treatment method based on the individualized needs of the patient.

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Prof. Dr. Istvan Urban, Hungary

Come by and see us
at the podium!

LEADING REGENERATION

The microbiology of peri-implantitis



Prof. Andrea Mombelli | Switzerland
Head of the Dept. of Periodontology
Dental Clinic of the University of Geneva

Interviewed by Verena Vermeulen

Are there any microbes which are complicit when peri-implantitis takes an especially severe course? And are microbiological tests worthwhile? Searching for clues at a micro-scale with Prof. Andrea Mombelli, Switzerland.

Prof. Mombelli, are peri-implantitis bacteria the same as periodontitis bacteria?

Prof. Mombelli: High microbial counts for various anaerobic bacteria can regularly be detected in implants with peri-implantitis. These include *Fusobacteria*, *Prevotella*, *Porphyromonas*, *Spirochetes* and *Peptostreptococci*. This anaerobic mixed flora is indeed very similar to periodontitis in natural teeth. But at times you find flora on an implant where *staphylococci* pre-dominate. This is untypical with natural teeth. *Staphylococci*, however, very often have a part to play in infections of orthopaedic implants outside the oral cavity and infections in catheters, etc.

Is the implant colonised from the outset or do the bacteria arrive later?

Prof. Mombelli: All dental implants are inevitably contaminated at placement. Even so, the great majority of implants heal without infection. Peri-implant infections may be the consequence of primarily non-microbial events, which encourage the emergence of a pathogenic microflora. We have explored this relationship in an article on the significance of biofilms in peri-implant disease¹.

An example is the subgingival persistence of adhesiveness, which can trigger a purulent bacterial infection that cannot solely be remedied through anti-infectious measures. The underlying cause must be eliminated for healing to take place. So the search for a specific cause always forms part of the differential diagnosis of peri-implantitis, even if pus or a biofilm point to a bacterial infection.

Do all patients have the same peri-implantitis bacteria?

Prof. Mombelli: The infection is typically a mix of bacteria that the patient also has elsewhere in the mouth. Then microecological factors influence the growth of the various microbes. For instance, a local mucosal inflammation may be due to deficient cleaning in an inaccessible niche.

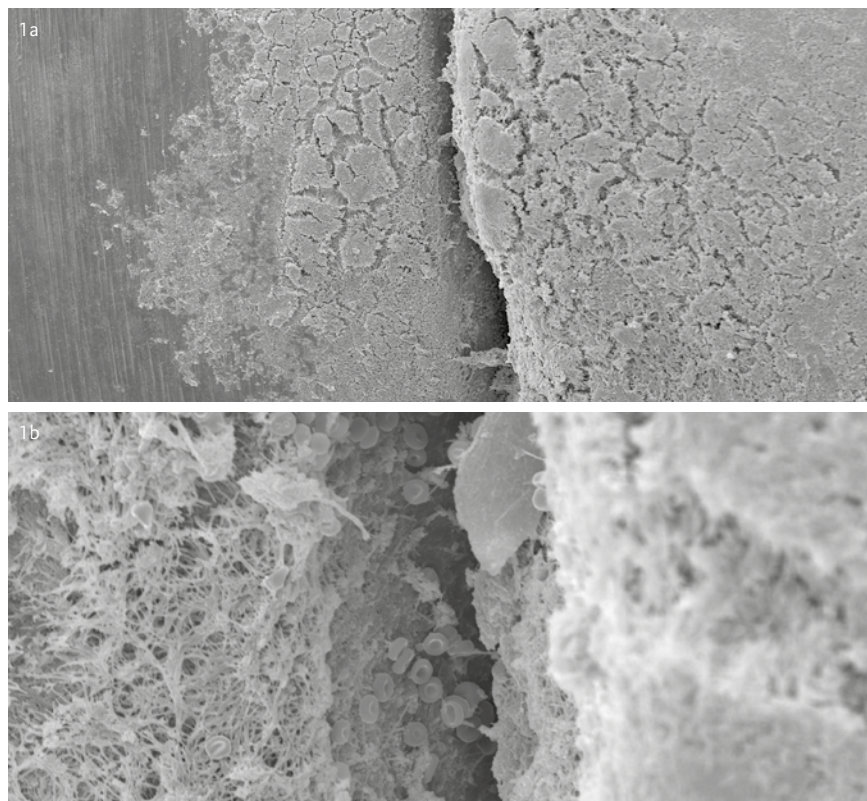
“Peri-implantitis has no specific pathogen behind it.”

Are there specific bacteria which are complicit in severe peri-implant infections?

Prof. Mombelli: No. Peri-implantitis does not develop due to an infection originating from an external specific highly pathogenic trigger. You can find all microbes in low numbers in the mouth, nose or throat area, even in clinically healthy individuals. *Staphylococci* are no different. So total eradication is an unrealistic treatment goal. Rather, the aim is to prevent an excessive build-up of potentially pathogenic microbes in the form of a biofilm.

Is there a good test for peri-implantitis bacteria? Should such a test be performed?

Prof. Mombelli: There is no clinical evidence showing any extra benefit from such tests over and above a precise clinical and radiological investigation. There is no cost benefit analysis for such tests either.



Photos: Mombelli

- 1a|b Biofilm in the gap between the implant (left) and the crown (right).
- 2 Peri-implant bone loss as a result of a purulent bacterial infection, triggered by excess cement.

Though I am very sympathetic toward colleagues and patients who would like to know more, I must say that the preventive and therapeutic options currently on the table do not require a bacterial test.

What systemic antibiotics are suitable for therapy?

Prof. Mombelli: From extensive studies in periodontology and the knowledge mentioned in relation to peri-implant flora, today we generally use a combination of amoxicillin and metronidazole. Our own multi-centric study and the work by other research groups have shown good results². For cases of intolerance, such as allergy to penicillin, just metronidazole by itself can be prescribed, but it is not effective against all incriminated microbes.

The additional remark that peri-implantitis cannot be successfully treated by purely pharmaceutical

means is very important. It always requires meticulous cleaning of the whole contaminated implant surface. In order to completely remove the biofilm, it usually has to be uncovered surgically.

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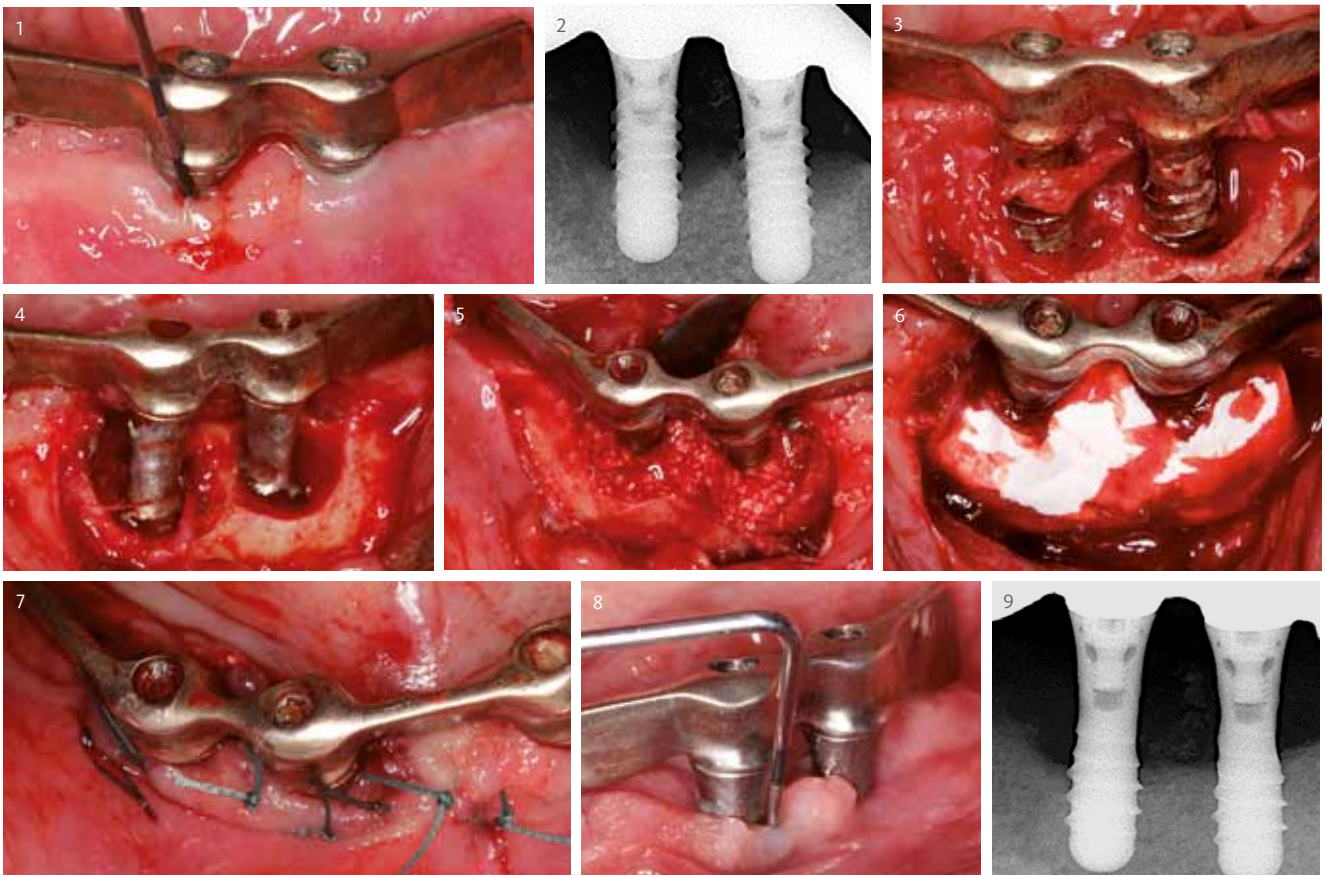
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Peri-implantitis therapy using regenerative surgery: Case studies



Prof. Frank Schwarz | Germany
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CASE 1



CASE 2



PHOTOS: SCHWARZ

Regenerative therapy should be combined with implant plastic surgery, if the configuration of a defect is advanced and complex.

In the first case, two bar-supporting implants have an advanced, combined (supra- and intraosseous) defect configuration with vestibular dehiscences and a supracrestal exposed screw thread (>1 mm). In such cases, after completely removing the granulation tissue, we start out by performing plastic surgery on the implant to smooth the implant body in the supra-crestal and buccal defect region. The portions of the implant surface facing the defect are structurally preserved and decontaminated (e.g., with a curette, Er:YAG laser and sterile saline solution).

The intraosseous defect components are then augmented with a slowly

resorbing bone replacement material. This is covered with a collagen membrane before the soft tissue flap is adapted tightly around the implants.

The second case involves circumferential intraosseous defects with a supracrestal component (<1 mm) on two adjacent implants. Such defects can be regenerated using bone grafting without plastic surgery on the implant.

What are the special considerations?

The plastic surgery smooths the macro- and microstructure of the implant body in the areas beyond the physiological barrier provided by current augmentation techniques. This encourages soft tissue integration and reduces bacterial deposition¹⁻². This therapy combined with Guided Bone Regeneration (GBR) in the intraosseous defect region reduces the probing pocket depths, increases the

clinical attachment level and ensures a long-term stable bone level³⁻⁶. The mucosal recession formation accompanying surgical procedures can be offset by a simultaneous soft tissue augmentation with a connective tissue graft⁷ or a porcine collagen matrix⁸. This allows treatment in the aesthetic zone. However, the complete loss of osseointegration necessitates explantation.

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CAPTIONS: CASE 1

- Bleeding and purulence on two implants in Region 33 and 34.
- The radiograph shows supracrestally exposed implant components.
- An advanced supra- and intraosseous defect is visible.
- Condition after plastic surgery on the implant for smoothing the implant body in the supracrestal and buccal defect region.
- The intraosseous defect area is filled with Geistlich Bio-Oss®.
- The Geistlich Bio-Gide® Collagen Membrane cut to size in situ.
- The edges of the wound are adapted tightly around the implants.
- Clinical situation free of inflammation at 18-months.
- Radiograph after 12-months – the structured implant components are covered at the bone level.

CAPTIONS: CASE 2

- Circumferential intraosseous defects with a supracrestal component about 1 mm in size.
- After removing the granulation tissue and decontaminating the implant surface, the defect is filled with Geistlich Bio-Oss® and covered with Geistlich Bio-Gide®.
- The radiograph 8-years after therapy proves the long-term stability and shows complete filling of the bone defect.

IMMEDIATE IMPLANT PLACEMENT UNDER SCRUTINY

Benchmark studies, selected and commented upon by
Prof. Niklaus P. Lang, Switzerland

“The immediate introduction of an implant cannot prevent surrounding bone from being resorbed.”

Araújo et al. 2005

“Buccal soft tissue recessions occur in 20 % of patients after immediate implant placement.”

Lang et al. 2012

“Bone resorption following immediate implant placement is irrespective of the geometry of the implants used.”

Sanz et al. 2010

Curse or blessing? Immediate implant placement has been debated since the 80's. Can osseointegration work at all? Does the technique end up with aesthetic failures? Prof. Niklaus P. Lang has selected and commented upon benchmark studies concerning immediate implant placement.

Is the gap an issue?

Implants are smaller in diameter than roots of teeth. If implants are placed directly into the fresh extraction socket instead of into bones that have fully healed, a gap therefore forms between the implant and the surrounding bone. This is also termed the "jumping distance" for the bone cells. When the topic of immediate implant placement emerged back in the 80's, there was discussion as to whether a gap is detrimental to new bone formation or osseointegration. Various authors viewed a gap width of >0.5 mm or >1 mm as critical.

"A marginal gap of >3 mm is no problem for the osseointegration of an implant."

Sanz et al. 2010

► **Botticelli et al. 2003** demonstrated for the first time in their preclinical study that the gap does not constitute a problem for osseointegration (**4 dogs, 1 control site and 3 test sites each, 4 months of follow-up**)¹. Their conclusion: a marginal defect of >1 mm can fully heal with new bone and a high degree of osseointegration in an implant with SLA surface. In a human study in ► **2004 Botticelli et al.** showed that even larger marginal gaps (≥ 3 mm) fill completely with new bone in eight out of nine cases (**18 patients, 52 marginal defects, 4 months of follow-up**)². However, at the same time the authors also measured – for the first time! – that bone is resorbed despite immediate implant placement, as had also been observed in the spontaneous healing of extraction sockets. The integration

of an implant therefore cannot prevent surrounding bone from being resorbed. Bone loss is particularly pronounced in the buccal region. The gap between the implant and the outer buccal bone wall was reduced by 56 % in the study, with the gap between the implant and the outer palatal/lingual bone wall reduced by as much as 30 %.

Should we close the gap using conical implants?

To close the gap between immediately placed implants and the surrounding bone, implant manufacturers eventually offered larger conical implants. ► **Lang et al. 2007** compared them with customary screw-shaped implants in a randomized clinical study (**208 patients, 208 immediately placed implants, 3 years of follow-up**)³. The study showed that larger, conical implants do not provide any additional benefit – neither in terms of the number of bone augmentations required at a later time (90 % in both groups) nor in terms of implant stability (measured according to the clinical immobility and the resonant frequency analysis value). However, the study showed that the number of soft tissue recessions could increase if larger conical implants were used.



Illustration: Büro Haeblerli

Is the gap a problem for osseointegration?

► **Sanz et al. 2010** was also not able to present any advantages for using conical implants in their randomized clinical study (**93 patients, 99 immediately placed implants, 4 months of follow-up**)⁴. They concluded: The shrinkage of the alveolar ridge following tooth extraction and immediate implant placement is irrespective of the geometry of the implants used. As observed by Schropp et al. (2003), they observed about twice as much buccal bone versus palatal loss (36 vs. 14 %).

The best healing form for immediate implant placement

In early publications on immediate implant placement, covered healing

of implants was almost always recommended. ► **Lang et al. 1994** first demonstrated the feasibility of immediate implant placement with transmucosal healing (**16 patients, 21 implants, 2.5 years of follow-up**)⁵. 20 out of 21 implants healed without difficulty in the study. From the authors' perspective the success factors were: (1) the preservation of the surrounding bone structures through careful extraction, (2) good primary stability, (3) close adaptation of the ePTFE barrier membrane around the implant, (4) close adaptation of the soft tissue flap around the implant and (5) careful plaque control with antibiotics at the outset and subsequent rinses of chlorhexidine (0.2 %) during the six-month healing phase.

Best positioning in immediate implant placement

As an important and, so far, sole randomized clinical study, the multivariate analysis of ► **Tomasi et al. 2010** dealt with what impact implant positioning in the extraction socket has on bone absorption and the aesthetic outcome (**93 patients, 4 months of follow-up**)⁶. Their conclusions: fewer exposed implant surfaces appear in the buccal region if the implant is preferably placed palatally (1–2 mm) than in the centre of the socket and also preferably 1 mm apically, with the implant shoulder just below the alveolar ridge. These conclusions were irrespective of other factors such as the thickness of the remaining bone walls, patient age,

smoker/non-smoker or the reason for the dental extraction (periodontal, cariological or traumatic). The preclinical study of ▶ **Caneva et al. 2010** also confirmed that the lingual positioning of an implant and deeper insertion into the socket bring about better aesthetic results (**6 dogs, 1 test site and control site each, 4 months of follow-up**)⁷. The authors therefore suggest that implants should be placed about 1 mm below the alveolar ridge and lingually/palatally from the middle of the extraction socket.

Implant survival and aesthetics

The ITI Consensus Conference in 2003 dealt with the different implantation times. For the conference ▶ **Chen et al. 2004** used an overview to compare the implant survival rates following immediate implant placement or later implantation (**31 studies**)⁸. Owing to the varying quality of the studies, they were only able to include four studies in the analysis, which had a follow-up period of three to five years.

From their analysis they concluded that with both options the implant survival rates in the short term are the same. But the authors also determined

that the long-term clinical success – peri-implant tissue health, aesthetics and function of the prosthetic restoration – did not lend itself to analysis and comparison, as there was hardly any data available.

▶ **Lang et al. 2012** in a systematic overview once again examined the survival rates of immediately placed implants after at least one year (**46 studies**)⁹. According to their analysis the two-year implant survival rate is 98.4%. If antibiotics were given for five to seven days after placing the implant, the rate

The ITI Consensus Conference differentiated between four time points for implantation.

Sanz et al. 2010

TAB. 1: ITI DEFINITION OF IMPLANTATION TIMES

TYPE 1	Immediately after tooth extraction
TYPE 2	Early implantation 4–8 weeks after tooth extraction, if the soft tissue has healed
TYPE 3	Delayed implantation 3–4 months after tooth extraction, if the bone is essentially clinically healed
TYPE 4	Late implant placement 6 months after tooth extraction, if the extraction site has fully healed

was slightly higher than in cases where antibiotics were given only once before the implant placement. But also the aesthetic problems were clearly exposed in the overview. The included studies, which had a follow-up period of at least three years, showed that buccal soft tissue recessions occur in 20 % of the patients after immediate implant placement.

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Bone loss in spontaneous healing, immediate implantation and regenerative measures

SPONTANEOUS HEALING

► **Tan et al. 2012** investigated in a systematic review **(20 human studies)**¹⁰ to what degree bone is resorbed in the event of spontaneous healing following tooth extraction. They showed that 11–22 % is lost vertically, 29–63 % horizontally within 6 months. The study evaluation further showed that the most pronounced losses occur in the first three months after tooth extraction, but successive bone volume is still lost afterwards. The authors suggest the resorption of the bundle bone (along the lines of Araújo and Lindhe 2005) as possible reasons for the pronounced buccal bone loss.

SPONTANEOUS HEALING VS. IMMEDIATE IMPLANTATION

► **Araújo et al. 2005** compared spontaneous healing and immediate implant placement in a pre-clinical study **(5 dogs, 2 immediately placed implants and 2 control sites, 3 months of follow-up)**¹¹. They reached the conclusion that immediate implant placement cannot prevent the socket walls from being remodelled. The bone height following three months of healing was comparable around immediately placed implants and spontaneously healed sites. The histology showed the buccal height to be about 1.9 mm lower than the lingual height.

SPONTANEOUS HEALING VS. RIDGE PRESERVATION

An important study by ► **Araújo and Lindhe 2009** showed that volume loss in an extraction socket is minimized by Ridge Preservation **(5 dogs, 1 augmented site and 1 control site each, 6 months of follow-up)**¹². Although the integrating biomaterial cannot prevent absorption of the bundle bone, the volume loss is significantly less after Ridge Preservation compared with spontaneous healing (12 % instead of 35 % after 6 months of healing).

IMMEDIATE IMPLANTATION VS. “FILL THE GAP”

In a human study ► **Chen et al. 2007** compared immediate implant placement without additional measures with immediate implant placement when simultaneously filling the gap around the implant with bovine bone replacement material **(30 patients, 10 implants without biomaterial, 10 implants with bone replacement material, 10 implants with bone replacement material and a collagen membrane)**¹³. They found that there was 50 % horizontal bone loss without biomaterial, but only 25 % horizontal loss with biomaterial. The integration of biomaterial had no impact on the vertical volume changes.

SHARKS – MASTERS OF REGENERATION.

Going beyond the oral cavity, we look at regeneration phenomena in nature. This time: sharks' teeth.



Teeth off the shelf

Dr. Klaus Duffner

After the “third” set of teeth, come the fourth, fifth, sixth... A shark’s jaw always has spare teeth waiting to regenerate throughout its life.

400 million years of evolution have evolved a shark’s teeth into a lethal tool. As opposed to man, sharks feature not a single row of teeth, but several rows at once. They form continuously in a dental comb on the jaws’ inner surface. Therefore there are always several consecutive stages of teeth forming at the same time.

To begin with, the rows of teeth are angled downward. After breaking through from the epidermis, they slowly straighten up. The straightening up and constant pushing forward of the teeth is enabled by a relatively free but nevertheless robust attachment to the connective tissue of the jaw cartilage. So sharks’ teeth, unlike mammalian teeth, do not have proper roots.

Snout packed with up to 240 teeth

Normally five rows of teeth are apparent, and as many as seven in a bull shark. As most teeth are still folded back, only a few are really in service. Cat sharks have three rows, and the mighty tiger shark only the foremost. Other shark species use all their rows of teeth at once. The absolute number of teeth varies between species of shark. The white shark, for example, has 23 to 28 teeth in the maxilla and 20 to 26 in the mandible. Five rows mean that such a predator has about 240 teeth in its snout.

On the attack: teeth go missing

Due to the advancing replacements, the teeth are ejected from the mucosa as time passes and are inevitably dropped. During attacks it is common for sharks to lose several teeth. Sharks’ teeth that have broken off are discovered time and

again in the skin of prey. Within a matter of hours, new teeth take the place of teeth that have broken off. Whereas most species of sharks renew their teeth individually, there are also species, such as the cigar shark that switch the whole set at once.

New teeth after just nine to twelve days

Data differ on the lifespan of sharks’ teeth. A University of Tübingen study, for example, found that leopard sharks replace their front teeth after just nine to twelve days. Replacement is 28 days in the case of the 5-foot nurse shark. Tiger sharks are said to lose about 140 teeth each year. Scientists stress that the regeneration speed not only depends on the species of shark, but also on the shark’s age and food range. Furthermore, there are indications that teeth last longer in colder water for some shark species.

Unique jaw strength

The white shark seems to have the greatest jaw strength of all the living animals. Using computer models, an international team of researchers has ascertained that *Carcharodon carcharias* can generate a force equivalent to 1.8 tons; i.e., a shark’s bite is about 20× stronger than a human’s.

The 50-foot long *Megalodon* probably had the all time strongest bite. This extinct giant shark managed to deliver an 18-ton bite. As a reference, lions bite with a power equivalent to a half ton, and the extinct *Tyrannosaurus rex* achieved 3 tons.

DENTAL SKIN

Even sharks' skin scales are structured like teeth. The little skin denticles are also responsible for the outstanding streamlined properties of sharks. If you pass your hand over the skin of a shark, it feels like sandpaper.

A BIGGER BITER THAN T-REX

The extinct giant shark *Megalodon* had a six times higher jaw strength than even the legendary *Tyrannosaurus rex*.

HOMOLOGY

Sharks' teeth are a co-production of the ectoderm and the underlying mesenchym. They are homologous to our teeth. Whereas the dental enamel develops directly under the oral epithelium, the dentin forms beneath the epidermal basal membrane.



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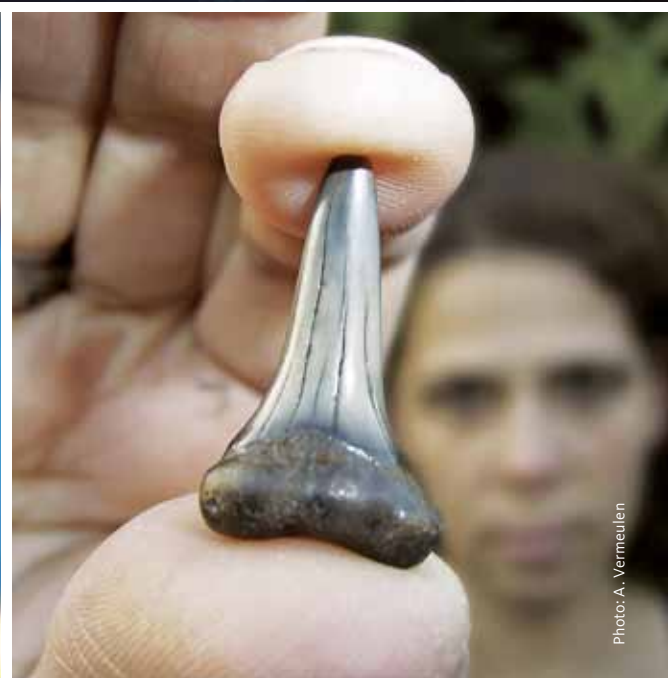


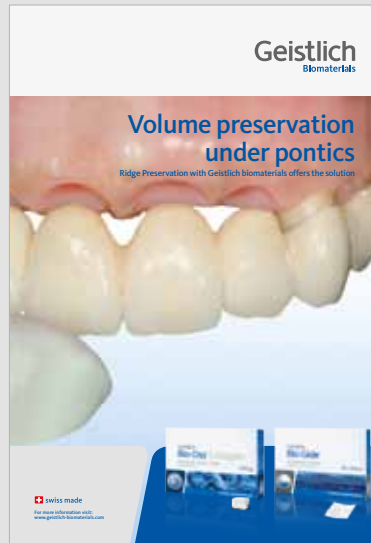
Photo: A. Vermeulen

BACKGROUND.

Geistlich Pharma & Osteology Foundation

New information brochures

Natalia Bruenisholz and Dr. David Maerki



Indication sheet “Peri-implant Augmentation”

Dr. Claude Andreoni and Dr. Thomas Meier, both from Switzerland, present two cases relating to augmentation and implantation in the aesthetic area.

Geistlich Bio-Oss® Collagen turns out to be especially practical for Ridge Preservation prior to implantation, because the dentist can simply incorporate it into the socket.

The experts use Geistlich Bio-Oss Pen® for implantations with simultaneous augmentation, because the applicator helps deliver the granulate at exactly the right consistency and in exactly the right amount.

To order, please contact your local Geistlich partner: www.geistlich-pharma.com/mycontact.

Leaflet “Volume preservation under pontics”

A Ridge Preservation with Geistlich Bio-Oss® Collagen and Geistlich Bio-Gide® helps to preserve ridge volume under a bridge.

The benefits of the technique are:

- › over 90 percent preservation of volume
- › prevents aesthetic, phonetic and hygiene problems
- › implant placement continues to be possible several years later

The brochure presents the scientific background, the step-by-step procedure and a detailed clinical case.

To order, please contact your local Geistlich partner: www.geistlich-pharma.com/mycontact.

Indication sheet “Fence Technique”

The “Fence Technique” permits a relatively gentle horizontal and vertical augmentation. Dr. Mauro Merli, Italy, explains the step-by-step procedure in a clinical case in a new indication sheet.

The core principle of this approach: an osteosynthesis plate serves as a rigid element that is used along with autologous bone, Geistlich Bio-Oss® and Geistlich Bio-Gide®.

Even complex alveolar ridge defects can be reconstructed using this technique, while at the same time reducing the invasiveness, morbidity and complications.

To order, please contact your local Geistlich partner: www.geistlich-pharma.com/mycontact.

“This approach combines minimal invasiveness with the creation of volume.”

Dr. Mauro Merli, Italy

“Science was his life”: Dr. Peter Geistlich (1927–2014)

Dr. Andreas Geistlich

President of the Board of Directors Ed. Geistlich Söhne AG



Dr. Peter Geistlich –
Scientist, entrepreneur &
unique man

If I had to summarize Dr. Peter Geistlich's entrepreneurial achievement from afar in a single sentence, then I would say: he ushered Geistlich into a new era and set milestones in regenerative medicine along the way. However, if you knew his impact and his singular nature, you would realize this does not go far enough. Almost exactly 60 years ago, having received his doctorate in chemical engineering from the Swiss Federal Institute of Technology (ETH), Peter Geistlich joined the Swiss family business, Geistlich, and shortly thereafter was

elected to the Board of Directors. In those distant post-war days – technical progress and growth were the order of the day – our company produced glue, fertilizer and gelatin on a huge scale.

Peter Geistlich entered the field of medicinal products at the company's headquarters in Wolhusen (CH), where antibiotic preparations and calcium products were produced, and third-party products were sold under license. Quickly and with great creativity, he started to look for his own products. As early as 1959 he

wrote the first patent for a drug substance to treat tuberculosis. In the 1970s he initiated business in medical body care products and cosmetics. He took over from his father as President of the Board of Directors of Geistlich in 1974.

Over the past 60 years the company achieved numerous successes, but also had to survive setbacks and hard times. These included the sale of the Mediline cosmetic range and the fertilizer business, as well as the demise of gelatin production. But Peter Geistlich was not discouraged. On the contrary, he always looked ahead, and time and again he started new projects with great enthusiasm. He could always count on the support and loyalty of his wife Annemarie Geistlich and the entire family.

With entry into medical technology in the 1980s, Peter Geistlich heralded the way for the company's transformation from an industrial to a technological company. The foundation was laid by Peter Geistlich's knowledge of bones and tissue, as well as his scientific collaboration with American Professors Myron Spector at Harvard University and Philip J. Boyne at Loma Lind University. Forged in a bond of friendship, these collaborative relationships are remembered today by the Philip J. Boyne and Peter Geistlich Professorship and the Osteo Science Foundation, started in 2013.

Philip J. Boyne had been searching for a bone replacement material for

oral and maxillofacial surgery. Peter Geistlich's idea was to produce something new and highly technological from the bones the family business processed industrially. And in fact it was soon apparent that the newly developed products – Geistlich Bio-Oss® and Geistlich Bio-Gide® – were well suited for bone augmentation in the jaw. These discoveries revolutionized implant technology: suddenly implants could be placed where it was previously impossible, when the underlying jaw had been too thin. Aesthetically dentists achieved better results with the new products from Geistlich. Geistlich has since established itself as a world leader in regenerative dentistry, and the products are used over a million times each year.

The Geistlich success story has been recognized through the Central Switzerland Innovation Award on two occasions, which brought Peter Geistlich a particular sense of satisfaction, as he had faced harsh criticism in the Swiss region of Entlebuch. Shortly before his death, Peter Geistlich received the Distinguished Humanitarian Award, which was a huge honour for him, recognizing his tireless efforts to benefit patients.

Over the years Peter Geistlich extended his concepts for the body's biological ability to regenerate to new areas, such as soft tissue regeneration and the treatment of cartilage defects in orthopaedics. His very special interest was in pharmaceutical substances and, above all, the medicinal product Taurolin, a substance with bactericidal action, which, as was later discovered, also shows a remarkable effect against cancer. Peter Geistlich believed in Taurolin and until the end of his life continued to shepherd it toward clinical use.

Science was his life: with 140 patents

to his credit, Peter Geistlich established his research talent. In order to find new means of regeneration and share them with dentists, in 2003 Peter Geistlich, together with the company, formed the Osteology Foundation. Exchange with scientists was very important to him. What was unimportant for him was ego. "Do good and talk about it" was not something Peter Geistlich espoused. He did good while also exercising modesty and restraint.

Peter Geistlich had ideas but he also listened, allowing fresh ideas to be pursued, while at the same time enjoying a certain 'fool's privilege' to investigate new ideas freely. Still, at the end of the day, every product had to be scientifically proven and watertight; otherwise, he would exercise his veto. His scientific integrity became the trademark of the company, like the precision of a Swiss watch. Geistlich continues to enjoy an outstanding scientific reputation – a reputation that is the essential and tangible contribution of Peter Geistlich.

As a man, Peter Geistlich was a leader with charisma and verve. He had a benevolent but also an unwavering side. He allowed his employees plenty of freedom, but without surrendering the reins of leadership. He was always committed to his employees' welfare. Very early he established a personnel retirement plan to safeguard the future of the staff, and he was always there to help when needed. His humanity and dedication will never be forgotten. To this very day the family character and the values of the company that he embodied are valued and respected by employees, partners and scientists at home and abroad.

Peter Geistlich's history and accomplishments will live on, even though Peter Geistlich is no longer with us.



1 Dr. Peter Geistlich

2 Dr. Peter Geistlich (left) with Prof. Christoph Hämmerle, President of the Osteology Foundation

Martin Luther once said: "Even if I knew that the world would end tomorrow, I'd plant an apple tree today." That is just the way Peter Geistlich thought. He always invested a great deal in science, and always with immense joy and enthusiasm for the potential of results – right up to his very last day. His beloved park in Wolhusen, in which he planted a sequoia only last November, will always remind us of this unique and talented man.

Successful cooperation on the topic of periodontology

Osteology Foundation Dr. Heike Fania

International experts gathered for four days at the 10th European Workshop on Periodontology, which had been organized in co-operation with the Osteology Foundation and the European Federation of Periodontology.

About 60 leading periodontal surgeons, scientists, clinicians and biologists met from 10–13 November 2013 in the Spanish La Granja de San Ildefonso for the 10th European Workshops on Periodontology.

In the workshop, organized jointly by the Osteology Foundation and the

European Federation of Periodontology (EFP), three working groups analyzed current studies and discussed options for incorporating scientific findings into clinical practice. The core topics of the discussions were wound healing and the regeneration of soft tissue – the clinical efficacy of different treatment options and surgical techniques.

The intensive study and detailed discussions in the working groups culminated in a total of eight review articles that have now been published in the *Journal of Clinical Periodontology*¹. They can be downloaded from the journal's website.

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Photo: EFP

The attendees at the 10th European Workshop on Periodontology.

News & dates

NATIONAL OSTEOLOGY SYMPOSIA 2014 AND 2015

Russia, Moscow

25–26 October 2014

Germany, Baden-Baden

18–19 September 2015

Brazil, São Paulo

30 September 2015

Italy, Florenz

1–3 October 2015

www.osteology.org/education/national-symposia

NEW OSTEOLOGY GRANTS – APPLY NOW!

In 2014 starting this Fall, the Osteology Foundation will be offering even more programs to promote research. In addition to the pre-existing Advanced Researcher Grants and the Young Researcher Grants, for the first time Large Clinical Grants will also be awarded for larger clinical research projects and scholarships, which are intended to enable young researchers to spend twelve months in selected research centers.

Please see the Osteology Foundation website for further details about the Osteology grants and applying. The next closing date for application is 1 December 2014.

www.osteology.org/grants/researcher-grants

Osteology supports peri-implantitis research

Osteology Foundation An interview conducted by Dr. Kay Horsch

One objective of the Osteology Foundation is to train researchers in scientific methodology. In this interview, Prof. Frank Schwarz, Germany, goes through what the foundation has to offer on the topic of peri-implantitis.

Prof. Schwarz, in your view is peri-implantitis an important research topic?

Prof. Schwarz: Yes, without a doubt. The etiology of peri-implant infections is multi-causal. It is a large mosaic that we have to painstakingly build up through further research activities. The constant advancement of materials, surfaces and designs for implants will also keep future generations of researchers on the go.

You have been conducting research into peri-implantitis for years. Can you see major progress?

Prof. Schwarz: One of the largest advances in the last few years has surely been more acute awareness of this clinical problem. Taboos have been removed, which now allow lively exchanges among participants in all congresses.

Research in the last few years has also managed to come up with very valuable therapy recommendations. We know that usually peri-implantitis has to be treated surgically, as non-surgical intervention is successful in only exceptional cases.

The Osteology Foundation offers “Best Practice” books and courses on research methodology. Does a “Best Practice” already exist in peri-implantitis research?

Prof. Schwarz: There are established, validated and outstandingly documented preclinical and clinical study models in this very research area. These models, however, require great expertise that researchers receive, for example, through the activities of the Osteology Foundation.

What would you recommend to young researchers who want to study in this field?

Prof. Schwarz: The recommendation is absolutely clear: enhance competence by networking. Today’s potential for an interdisciplinary research approach must be comprehensively exhausted, especially for this area of research. Industry should remain “thick-skinned” and open to new developments. Peri-implantitis is a “fearful” topic and continues to be quite unpopular with some experts, which is one more



Interview with Prof. Frank Schwarz

reason to research openly and honestly in this direction.

How does the Osteology Foundation back peri-implantitis research?

Prof. Schwarz: The Foundation offers options both for upcoming young scientists and also for established working groups. On one hand, the “Best Practice” books and the Osteology Research Academy course are very helpful to researchers. The Foundation also gives financial backing to research projects. For example, a study of our working group on the topic of peri-implantitis was sponsored and even awarded the Miller Prize of the German Association for Dental, Oral and Maxillofacial Medicine.



Dr. Stephen Chen is a specialist periodontist with a private practice in Melbourne, Australia. He chaired the scientific program committee of the ITI World Symposium 2014 in Geneva, where we met him for a chat.

Photo: Thomas Gerber

A cup of Tea with Stephen Chen

The interview was conducted by Verena Vermeulen and Reto Falk

Dr. Chen, has one particular day in your working life affected you more than others?

Dr. Chen: Actually, it's more people than moments that have been meaningful; for example, when I met Christer Dahlin on a delegate bus in Philadelphia in the early 1990s. He didn't know me at the time, but we started talking and ended up publishing our paper on extraction socket management together in 1996.

Have you ever regretted your decision to become a dentist?

Dr. Chen: Never! After studying dentistry for two years, I switched to general medicine. Even though I knew it would be more prestigious in the long run, I didn't enjoy it. So I asked my professor if I could return to dental medicine. He agreed and I have never looked back. I have also never regretted focusing on Periodontology; the way periodontists think has really impacted dental implant practice.

If you had unlimited research funds, in which area would you invest?

Dr. Chen: I would stay in the field of regeneration, searching for ways to improve patient therapy. In many instances, we still use autologous bone and soft tissue, and it is important to improve this situation.

Do you have a hobby that your colleagues don't know about?

Dr. Chen: My whole family is crazy about football. We also love music: I sing in a community choir and my sons are talented musicians. Music is a wonderful balance to working life.

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appears in April / May 2015.

FOCUS

Large bone augmentations

What do you do if volume is missing in the jaw?

JOURNAL CLUB

Soft tissue

Benchmark studies on how to treat oral soft tissue correctly

OUTSIDE THE BOX

Regeneration of central nerves

Suddenly what was considered utopia now seems possible: healing paraplegics.

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