Research Review Speaker Series™

Dental implants: assessment and maintenance

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Dr Leichter is a Senior Lecturer in the Department of Oral Sciences at the University of Otago. He joined the faculty after 20 years in fulltime private practice in New York and Boston, 18 of which were spent in specialist practice limited to periodontology and implant dentistry. After training at Tufts University, Dr Leichter undertook specialist training at Harvard University, and has been actively involved in clinical dental implant practice since 1984. Since 2002, he has supervised and mentored postgraduate students in periodontology, endodontics and prosthodontics.

Dr Leichter's research interests and publications are in the field of periodontology, dental trauma and laser applications in dentistry.

This publication is a summary of Dr Jonathan Leichter's presentation delivered to general dentists, oral surgeons, periodontists and prosthodontists on 13 August 2011, in Blenheim. This presentation on the assessment and maintenance of dental implants highlighted the similarities and differences between inflammatory diseases affecting implants (peri-implantitis) and teeth (periodontitis and gingivitis).

Management of implants

Implant maintenance is critical for long-term success. Patients with dental implant prostheses require customised protocols for professional maintenance and home care. Failure to properly observe these protocols may result in peri-implantitis and catastrophic consequences for the patient: the implant may have to be removed, leaving huge alveolar defects. Patients who are left with insufficient bone to support another implant may not be able to have other types of fixed restorations, due to the anatomic defects that are left.

Disease entities

• Peri-implant mucositis

This inflammatory disease, analogous to gingivitis, is a very common finding characterised by redness, swelling, and inflammation of tissue directly adjacent to the fixtures. The inflammation is confined to the mucosa. Notably, this condition is reversible and does not damage the underlying supporting bone, which maintains the dental implant.

• Peri-implant mucosal hyperplasia

This is another common inflammatory disease, analogous to gingival hyperplasia on natural teeth, commonly associated with plaque. Usually, there is a proliferation of soft tissue around the implant fixtures. Fixtures can become engulfed by fibrotic overgrowth of the soft tissue adjacent to the fixtures.

All of these conditions can be controlled and monitored through appropriate home maintenance and care. Like peri-implant mucositis, peri-implant mucosal hyperplasia does not compromise the underlying supporting bone. In Dr Leichter's experience, lasers (whether Diode- or Erbium-based) have proven very effective in both the management and treatment of peri-implant infections. Indeed, at the University of Otago, dental lasers comprise one of the front-line treatment modalities, with excellent outcomes.

• Peri-implantitis

This inflammatory disease, analogous to periodontitis in natural teeth, results in the destruction of the supporting bone around the dental implants, with exposure of the implant, threads and rough surface. This condition may be treatable, but it is not reversible. The loss of supporting bone around the implants is a highlight of this disease, just as periodontitis in natural teeth is associated with loss of attachment and irreversible damage.

Table 1 summarises the three diseases, all of which are associated with dental plaque, just as the inflammatory diseases around teeth are associated with plaque. Notably, Dr Leichter suggested that although plaque is considered to be the sole aetiological agent for periodontitis, this may not be the case for peri-implantitis. He predicts that ongoing research at the University of Otago will eventually highlight some of the novel factors that may be contributing to loss of bone around titanium implants. All of the above three diseases are associated with bleeding, not necessarily with pain, and suppuration. Only peri-implantitis is associated with loss of bone and if there is any mobility associated with the implant fixture, it cannot be resurrected. Dr Leichter emphasised that a mobile prosthesis can be rectified, whereas the only treatment for a mobile implant is its removal.

Table 1. Features associated with peri-implant mucositis, peri-implant mucosal hyperplasia, and peri-implantitis –modified from Schwarz and Becker[a]

	Peri-implant mucositis	Peri-implant mucosal hyperplasia	Peri-implantitis
Reversible	Yes	Yes	NO
Plaque accumulation	Yes	(Yes)	Yes
BOP	Yes	Yes	Yes
Pain	Yes	(Yes)	Yes
Pocket Formation	No	Yes	Yes
Suppuration	No	No	(Yes)
Swelling	(Yes)	Yes	(Yes)
Redness	Yes	Yes	Yes
Bone resorption	No	No	YES!!!
Implant mobility	No	No	You are in trouble if this is present!!

[a] Modification of table reprinted from Schwarz F, Becker J (Eds.). Peri-implant infection: etiology, diagnosis and treatment. Quintessence Publishing. 2009.

"Implants have a 95% success rate over 10 years"

Although commonly cited, this statement is not substantiated by the literature. Dr Leichter emphasised that a 95% success rate is a very different proposition from a 95% survival rate.

The literature testifies to the presence of peri-implantitis in a vast number of dental implants – not just 5% (see Table 2).[1-7] There is also evidence of peri-implantitis clustering in groups, as for instance in the data from Fransson et al. (2005),[5] in which 12% of implants were associated with bone loss and progressive bone loss in 27% of patients. In the Renvert study,[7] peri-implantitis developed in 43% of implants. A recent assessment of subject-based data from the Sahlgrenska Academy at the University of Gothenburg, Sweden, has reported that 28% of subjects had one or more implants with progressive bone loss, that about 40% of the implants in each affected subject had peri-implantitis, and the proportion of such implants varied between 30% and 52% in different jaw positions (30% in lower jaw, 52% in upper jaw).[8] Dr Leichter pointed out that these data have important Accident Compensation Corporation (ACC) implications, as the vast majority of implants that are placed under ACC are in the maxilla. Dr Leichter emphasised that these are associated with the highest failure rate of any implant; not only are these implants being placed in the most vulnerable positions, but patients are being assured of a 95% success rate, despite all evidence to the contrary.

Table 2. Study data citing the prevalence of peri-implant mucositis and peri-implantitis–modified from Schwarz and Becker[a]

Study	Implant system	Number patients/ implants	Mean function time/range	Peri-implant disease (BoP) % patients/ implants	Peri-implant mucositis % patients/ implants	Peri-implantitis % patients/ implants
Scheller et al. (1998)[1]	Brånemark	57/59	5 years	24% implants	–	–
Polizzi et al. (2000)[2]	Brånemark	86/163	5 years	27.3% implants	–	–
Baelum & Ellegaard (2004)[3]	Astra/ITI	140/211	10 years	50% implants at 5 years 90% implants at 10 years	–	–
Karoussis et al. (2004)[4]	ITI	89/153	8–12 years	–	–	15% implants
Fransson et al. (2005)[5]	Brånemark	662/3413	5–20 years	–	–	27.8% patients 12.4% implants
Fransson et al. (2008)[6]	Brånemark	82/482	9.4 years	100% patients/ 92% implants	–	–
Renvert et al. (2007)[7]	Brånemark	216/987	9–14 years	75.4% implants	79.2% patients/ 50.6% implants	55.6–77.4% patients/ 43.3% implants

[a] Modification of table reprinted from Schwarz F, Becker J (Eds.). Peri-implant infection: etiology, diagnosis and treatment. Quintessence Publishing. 2009.
BoP = bleeding on probing.

Survival does not equal success!

The International Congress of Oral Implantologists (ICOI) has released definitions regarding implant success, implant survival, and implant failure:[9]

- SUCCESS <2 mm bone loss from initial surgery after 1 year;
- SATISFACTORY SURVIVAL 2–4 mm of bone loss;
- COMPROMISED SURVIVAL >4 mm bone loss. Probing depth >7 mm;
- FAILURE Mobility.

Dr Leichter questions how "success" can be defined as bone loss of 2 mm after 1 year. Instead, he defines success as:

- No mobility;
- No peri-implant radiolucency;
- Less than 0.2 mm of bone loss annually after the first year of function;
- No pain;
- Can be restored.

Good Straumann implant evidence demonstrates that the same slow, chronic loss of bone is not apparent with the Straumann implant system. While Dr Leichter is not advocating for Straumann implants, he noted that different criteria exist for bone level and transmucosal implants.

Of aetiological agents in peri-implant infections, the primary factor appears to be bacterial plaque biofilm, as it is with natural teeth. Other risk factors include:

- Past history of periodontal disease
- Smoking
- Poorly controlled diabetes
- Alcohol consumption
- Bone augmentation (Dr Leichter noted that implants placed in grafted sites are not as successful as those placed in virgin sites)
- Occlusal overload
- Implant surface texture
- Head and neck radiation
- Bisphosphonates (Dr Leichter thinks it necessary to advise patients)
- Maxilla (notably, implants placed in the maxilla have a significantly worse survival rate than implants placed in the mandible).

Researchers at the University of Otago are investigating other theories for causes of peri-implantitis. One emerging theory implicates surface degradation, whereby it is thought that it is not the bacterial accumulation on the root that is causing the immune response, as happens with periodontitis, but rather, the bacteria degrade the titanium surface and thereby change the electrochemical configuration of the surface, initiating a hypersensitivity and inflammatory reaction in the tissue. Intriguingly, tissue from peri-implantitis cases examined by scanning electron microscopy is invariably revealing particles of titanium, which lends credence to this theory.

Intra-oral assessment

Intra-oral assessment includes continuous assessment of the prosthesis and soft tissue. In addition, the source for any mobility must be identified (i.e., prosthesis or fixture).

He stressed the importance of assessing the prostheses. *A radiograph must be taken of the implant-supported prothesis*, to check that it is on the fixture. The highest level of accuracy and meticulous execution is paramount, to ensure success with these fixtures.

Bleeding on probing may be another finding of the intra-oral examination. It is probably one of the single most important factors for natural dentition and soft tissue around implants, said Dr Leichter. Probing is essential, whether it be with plastic or metal instruments. He added that while it is widespread practice to take bite wings and posterior radiographs to check for dental caries, anterior radiographs are far less commonly performed. However, most of the implants placed in New Zealand are anterior implants; failing to undertake a radiograph to monitor implants amounts to passive neglect. Dr Leichter urges routine x-rays of all implant fixtures. Probing and radiographs should be part of a constant and ongoing assessment of the prothesis and supporting implant fixtures.

Radiographic assessment

Radiographic assessment should comprise the following:

- Standardised assessment (i.e., perform them at the same angle)
- Continuous assessment
  - Baseline at prosthetic delivery
  - 1 year if no symptoms
  - 3 years if no symptoms (even in the anterior)
- 6–8 months until stable.

Dr Leichter urged caution in placing implants adjacent to failing root canal treatment.

Major clinical parameters

Look for the following factors:

- Plaque
- Bleeding on probing
- Suppuration ???
- Probing depth
- Radiographic bone loss
- Mobility NO!

Pocket depth is a little problematic; a 4 mm pocket does not necessarily mean the same for a tooth as for an implant. An implant placed deep into thick fibrotic tissue will mean deeper pockets from the outset. Look for changes in the pocket depth, versus the pure number.

Prevention/Treatment

A strategy is needed to manage dental plaque, whether this be patient-centred management or dentist/hygienist-centred management. Of all available preventative procedures, none is considered to be of greater importance than the care an individual can provide for himself. Indeed, prevention is the single most important aspect of dentistry.

Various tailored strategies are available for patients' mechanical removal of plaque, including Super Floss, interproximal brushes, and adjunctive oral rinses. The removal of plaque is critical.

Treatment of implants

Implants are treated according to the spectrum of presentation. The Cumulative Interceptive Supportive Therapy (CIST) protocol (Fig. 1) is recommended.[10] This protocol includes 4 treatment modalities: A = mechanical debridement; B = antiseptic treatment (Chlorhexidine rinse and irrigation .1–.2 and .2 to .5%); C = antibiotic treatment; D = regenerative or resective surgery; E = explantation.

Figure 1. Cumulative Interceptive Supportive Therapy (CIST) protocol[10]

Plaque	BOP	Suppuration	PD mm	RX defect	Classification	CIST
Possibly	No	No	<4	No	0	(A)
Yes	Yes	No	<4	No	1	A
Yes	Yes	Possibly	4 to 5	Yes +	2	A+B
Yes	Yes	Possibly	>5	Yes ++	3	A+B+C
Yes	Yes	Possibly	>5	Yes +++	4	A+B+C+D
Yes	Yes	Possibly	>5	Yes ++++	5	E

For peri-implant pocketing <3 mm with no visible plaque and no bleeding on probing, no treatment is required. If however, plaque and bleeding is present, mechanical debridement is necessary.

Removing all deposits from all surfaces is achieved through mechanical, chemotherapeutic and photodynamic means, hand scaling and powered/dynamic scaling. Dr Leichter commented that worrying about scratching the implant surface is not a realistic concern; most scaling involves the abutment, or the crown. Titanium curettes are available, which will not damage or scratch the implant surface. Ultrasonic tips for implants avoid harming the surface. Plastic curettes are available, but their large size and bulkiness makes them very difficult to use effectively on gingival sulcus.

Mechanical debridement of the biofilm is also very important. Dr Leichter likes to use ultrasonic instrumentation that have the following features:

- 20,000–40,000 cycles/second.
- Magnetostrictive – elliptical.
- Piezoelectric – linear
  - Acoustic Streaming
  - Acoustic Turbulence
  - Cavitation.

Power scalers are contraindicated in the following situations:

- Patients who gag easily
- Sensitive exposed root surfaces
- Composite resin and porcelain restorations (fracture risk)
- Patients with pacemakers.

Power scalers are risky in infectious patients, because of contaminated aerosols and infected splatter. Dr Leichter and colleagues incorporate a pre-procedural rinse, to help suppress the oral bacteria prior to using ultrasonic instrumentation. He noted that the aerosol can remain in the air for up to 30 minutes after the procedure has started or after the patient has left.

Of available choices for pre-procedural rinses, Essential Oils (Listerine®) may be helpful. Rinsing with Listerine before ultrasonic debridement has been shown to dramatically reduce infectious agents in aerosols.[11] Thus, whether treating peri-implantitis or periodontitis, performing routine preventive treatment on a patient, or undertaking restorative treatment, if there is going to be an aerosol, good evidence shows that pre-procedural antimicrobial rinsing significantly reduces the risk of infectious agents for both the practitioner and patient.

For treatment of peri-implant pocketing >3 mm, if there is no bone loss compared to baseline, no treatment is required in cases with no visible plaque or bleeding on probing. If, however, plaque and bleeding on probing are present, local debridement is necessary and any hyperplasia may be resected surgically with a laser or scalpel. Dr Leichter and colleagues have had good success with the Diode Laser for removing gingival hyperplasia, without affecting the implant surface.

For peri-implant pocketing >3 mm with loss of bone compared to baseline, treatment depends on whether the case is classified as mild, moderate, or severe:

Mild: local debridement, surgical resection, topical antiseptic, local delivery antibiotic, systemic antibiotic.

Moderate: local debridement, topical antiseptic, local delivery antibiotic, systemic antibiotic, open debridement.

Severe: local debridement, systemic antibiotic, open debridement, explantation.

Dr Leichter advised that while general dentists can treat implants with peri-implant mucositis, cases of peri-implantitis or loss of bone should be sent to the periodontist. The technology and strategies for treating peri-implantitis are still emerging; such cases should be managed by those who are developing these strategies.

Antiseptics/biocides

- Only two antiseptics have a large body of supporting data from ≥6-month clinical trials
- Support for use as an adjunct to conventional mechanical oral hygiene – Essential Oils (Listerine) and Chlorhexidine®
- Both capable of penetration of plaque biofilm.

Chlorhexidine is recognised as the gold standard against which other antiplaque agents are measured, but Dr Leichter is not sure why this should be so. Besides its bad taste and staining, one of the side effects of Chlorhexidine is that it forms calculus supragingivally. While Chlorhexidine does suppress plaque and gingival bleeding, the creation of calculus is a plaque-retentive feature.

An alternative is Essential Oils. While some people complain of the burning taste associated with Listerine, it does not stain or suppress taste, and it is not capable of calculus formation. Listerine does penetrate the biofilm, with a very dramatic reduction on both plaque and bleeding. Dr Leichter suggested that the gold standard might have to be revisited. A very viable alternative exists in Listerine (see Fig. 2).

Figure 2. Comparison between Essential Oils and Chlorhexidine

Essential Oils	CHX
• Gram negatives and positives, fungi & viruses (wide spectrum)	• Gram positives mostly Mutans streptococci
• Synergistic combination of essential oils	• Narrower spectrum but also fungi & viruses
• Established plaque (layers 4-7 of plaque)	• First stages of plaque formation
• Non-charged (anionic) molecule; penetrates by diffusion	• Charged (Cationic) molecule; binds to outer layers of plaque and also Fluoride & Sodium Lauryl Sulphate
• No substantivity but 12 hr efficacy	• Substantivity 24 hours
• Side FX: taste	• Side FX: Staining, taste, calculus formation, allergic reactions

Dr Leichter added that a recently released meta-analysis has conclusively shown that ethanol-based mouthwashes are not associated with oral cancer risk.[12] The investigation found no statistically significant association between mouthwash use and risk of oral cancer, including no significant trend in risk with increasing daily use and no association between use of mouthwash-containing ethanol and oral cancer risk. These findings were replicated in healthy non-smoking populations, smokers and drinkers. Dr Leichter added that the ethanol in the mouthwash acts as a vehicle to help the antiplaque agents perform optimally; to reduce the plaque and attack the bacteria.

If an antibiotic regimen is needed for the treatment of peri-implantitis, data are still emerging as to the most appropriate regimen. Typical regimens are metronidazole-based:

- Metronidazole 200–400 mg 3 times daily for 4–7 days;
- Metronidazole 200 mg 3 times daily and amoxicillin 500 mg 3 times daily for 4–7 days.

The combination of metronidazole plus amoxicillin is very effective, but is commonly associated with diarrhoea, nausea and vomiting.

Diode- and Erbium-based lasers have proven very effective at the University of Otago in the treatment of peri-implantitis; these comprise the Odyssey® 2.4G Diode Laser, a high performance soft tissue laser that has an 810 nm wavelength and operates in continuous or pulsed-wave modes, characterised by ready absorption into body pigments and haemoglobin. The Erbium:YSGG laser (Waterlase MD®) has a 2780 nm wavelength, is more highly absorbed by OH ions than water molecules, and is designed for both hard and soft tissue applications.

Risk factors for developing peri-implantitis are summarised in Figure 3.

Figure 3. Risk factors in the development of peri-implantitis–modified from Schwarz and Becker[a]

		Low risk	Medium risk	High risk
Systematic Factors	Periodontal disease	Gingivitis	Treated periodontitis	Untreated periodontitis
	Oral hygiene	PI < 1	PI = 1-2	PI > 2
	IL-1 polymorphism	no	< 10 cigarettes/ day	> 10 cigarettes/ day
	Alcohol consumption	no	-	yes
	Diabetes	no	< l0g/day	>l0g/day
	Gingivitis desquamativa	no	controlled	uncontrolled
	Biophosphonate medication	no	-	yes
Local Factors	Implant type	cylindric	screw-type	hollow cylinder
	Biofilm removal	machined	HA/TPS	SLA
	Re-osseointegration	SLA	HA/TPS	machined
	Implant location (zone)	nonesthetic	nonesthetic/ esthetic	esthetic
	Defect classes	-	Ia Ib Ie	Ic Id II
	Keratinized mucosa	sufficient	reduced	absent

[a] Modification of figure reprinted from Schwarz F, Becker J (Eds.). Peri-implant infection: etiology, diagnosis and treatment. Quintessence Publishing. 2009.

Take home message:

Continuous assessment, early interventions and a tailored oral hygiene programme are essential for implant patients.

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