The concept of “platform switching” in implant dentistry

A literature review—Part I

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_Over the last decades, osseointegrated dental implants have proven to be highly predictable and largely accepted as treatment modality for the rehabilitation of partially and completely edentulous jaws.

Being considered the most aesthetical and functional alternative to missing teeth, dental implants are used as prosthetic supports and expected to withstand complex occlusal load. However, they also have to confront the effects of additional factors such as oral microflora or elevated parafunctional forces.

_Introduction

Several factors such as implant design and surface, implant abutment interface or connection, bone architecture, prosthodontic restoration type and loading conditions may have effect on bone modelling and remodelling around the implants.

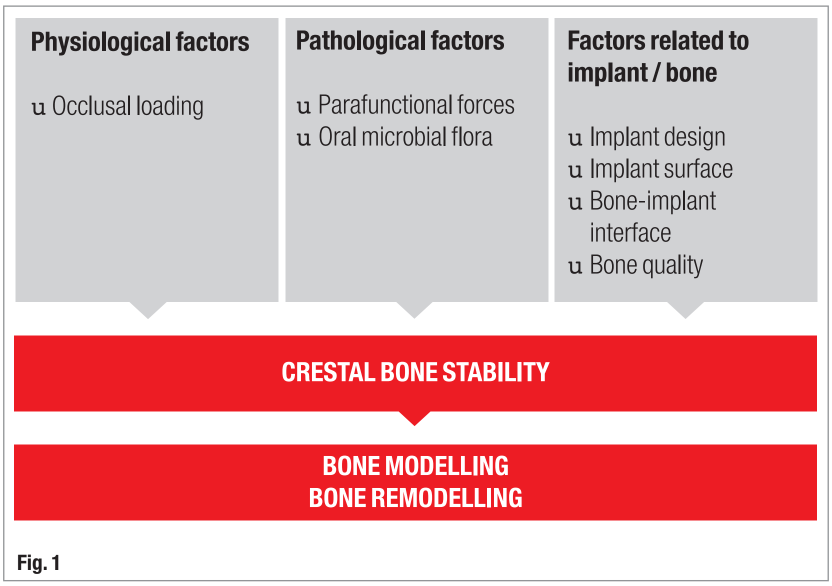

Fig.1_Factors affecting bone changes around titanium dental implants

The generally accepted criterion for implant success is that less than 0.2 mm of alveolar bone loss per year should occur after the first year in function.[1]

What is overlooked, however, is that the implant therapy success is determined after the first year of service because most of the bone loss occurs during the first 12 months following abutment connection.[2]

Therefore, the 2 mm loss of crestal bone over the first year might be considered a normal characteristic of a healthily functioning implant and this change in bone height is merely due to remodelling in response to loading.

The questions that need to be redressed are whether this small amount of bone loss exerts any clinical significance and whether it can be considered acceptable.

Dental implants have two goals to fulfil: an aesthetic one and functional one. The loss of crestal bone and soft tissue may have important implications for aesthetic implant restorations, which are reliant on healthy and constant soft tissue dimensions over time. The aesthetic replacement of teeth has become an important standard for implant dentistry, leading to further research regarding the factors contributing to crestal bone loss around two stage implants (Fig. 1).

Bone adaptation under loading conditions

Bone is a tissue that changes its mass and internal architecture adapting itself to the loading con-

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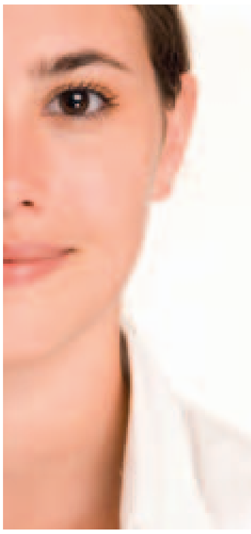

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More information and registration: www.camlogcongress.com ditions. According to Wolff's law[16], every change in the form and function of bone is followed by modifications in its internal architecture and external conformation. The dimensions and orientation of trabeculae are adaptable in accordance with changes in loading trajectorial vectors and, when equilibrium is found, trabecular patterning represents the average regime experienced by the bone.[17]

Mechanical stimuli affect bone response and exert influence on the replication and differentiation of mesenchymal cells toward the osteoblast lineage.[18]

Frost's theory

Frost stated that bone mass changes when absolute peak strains induced inside the bone fall either below or above the physiological window estimated between 200 and 1,500 microstrains.

Fig. 2_Frost's Mechanostat theory.

4,000 – 6,000 microstrains PATHOLOGICAL LOAD =>fracture
1,500 – 4,000 microstrains OVERLOAD => bone resorption
200 –1,500 microstrains PHYSIOLOGICAL LOAD => bone apposition

Fig. 2

The application of this theory Fig. 2 to dental implant rehabilitation explains bone resorption at the crestal level of loaded implants, a condition that may occur because of the stress shielding effect, due to both the solid metal structure of the implant and the implant design. These features can play a role on load transfer to the bone, reducing strain magnitude under the lower physiologic threshold and, thus, promoting osteoclast resorption at the crestal level.

The rigid metal structure of the implant acquires most of the occlusal stresses, transferring them deeper into the basal bone, excluding the crestal bone from the physiologic stimulation. Implants with a slim design at the crestal level, for example, demonstrate a wide bone formation, corroborating Frost's theory.

Effect of implant geometry on the marginal bone

Implant design consists of the combination of the implant body three-dimensional geometry, presence of threads, thread design, surface topography and surface treatments that may affect strain stimulation of peri-implant bone.[20]

Finite element analysis reported that tapered implants present a better mechanical performance than cylindrical implants to avoid punching stresses.[21, 22] It has been demonstrated that threads and their location on the implant body have a role in the load transferring pressure patterns to the bone.[23]

The outcome of comparative clinical research on different implant systems have reported analogous marginal bone loss per year (1–3), even if smooth surfaced implants with a conical collar have demonstrated higher bone loss than self-tapping and standard implants.[29, 30]

In this respect, marginal bone loss might be primarily related to the smoothness of the implant surface, leading to stress protection, and thus, to bone resorption (bone shielding).[31]

Effect of the implant surface on the peri-implant bone

Surface microgeography plays a primary role in facilitating biological interactions between bone precursor cells and implant.

Rough implant surfaces facilitate high osteoblast adhesion levels[24], and since osteoblasts are spread on implant surfaces, the roughness seems to induce osteoblasts toward synthesis and the release of biological factors affecting the tissue response at the interface. Surface roughness is a crucial factor affecting bone apposition at the interface and improving the interface resistance because of better mechanical interlocking.

However, increased bone mass around rough surfaces may also be attributed to a lower bone remodelling level during the early stages of implantation, as reported in a comparative research study between plasma sprayed and smooth surfaced implants.[25, 26]

A poor implant design like smooth machined coronal part could be related to a reduction in mechanical interlocking between implant and crestal bone, acting like a stress shield and inducing crestal bone loss.[27, 28]

The stability of the peri-implant cervical bone around the neck of the implant and the absence of resorption are the key to maintaining gingival papillae and bone in the anterior region.

According to reference literature, several changes should occur after abutment connection. Bone resorption of approximately 2 mm from the implant abutment junction[3] should occur circumferentially, noticeable on the buccal plate.

Preliminary evidence suggests that anticipated bone loss occurring around two-stage implants, following loading, or surgical stage 2, may be reduced or eliminated when implants are restored with smaller-diameter abutments on larger platforms.[4, 5]

The interface between abutment and implant, or the microgap, is subject to micro movements and bacterial seeding, and, if it lies at or below the crest of the bone, prompts osseous resorption for these reasons.

Bone preserving techniques such as platform switching have been utilized for more than ten years (Fig. 3).

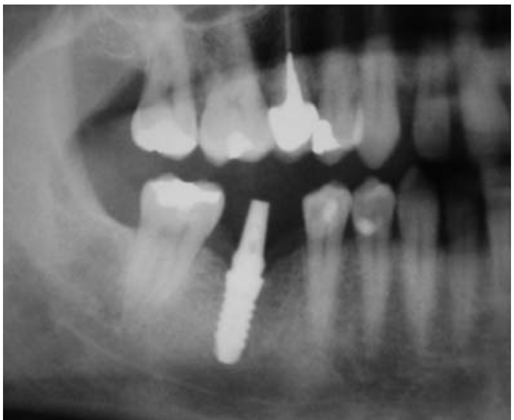

Fig. 3

Fig. 3_The platform switching concept (X-ray courtesy Dr. R. Vollmer, G. Golecki)

The answer to these questions may be of an important support in choosing the implant system, able to switch the platform, which can face high implant—aesthetic demands.

Is the concept of platform switching a bone preserving technique and, if so, is this reproducible?

Is this concept alone able to preserve bone?

Is the platform switching concept evidence based?

_Materials and methods

The aim and objectives of this review have been to examine the scientific validity of claims that platform switching concept improves implant performance, being a bone preserving technique.

These claims have been analyzed against historic background, findings and conclusions of published implant studies.

A literature search of paper published in reference journals in the English language was performed by computer using the National Library of Health.

PubMed—the government search engine for the National Library of Health, National Institute of Health MEDLINE database: http://www.pubmed.gov, has been used as the primary source of data.

Google Scholar Search engine and different Journals and books have been employed as a secondary source.

PubMed search for the key words "implant platform switching concept" ended in 10 and Google Scholar in 3,110 results for the same key words in 0.07 seconds.

These results show an ever—growing interest in this subject which is very challenging for the peer reviewed literature to keep up with.

Manual search of IJOMI—International Journal of Oral and Maxillofacial Implants with back issues from 1996 to 2009 revealed very few results.

The reference list of identified publications and textbooks were scanned.

The first selection method consisted in a relevant references selection on the basis of titles and abstracts.

The final selection method being possibly rele-

Site	Type of implants	No. of implants	Bone res. (mm) after 1 year	Bone res. (mm) after 2 years	Bone res. (mm) after 3 years	Bone res. (mm) after 4 years	Bone res. (mm) after 5 years
Maxilla PS*	*3i* ext. hex	50	0,6+/-0,2	0,6+/-0,2	0,6+/-0.2	0,6+/-0,2	0,6+/-0,2
Mandible PS	*3i* ext. hex.	47	0,5+/-0,2	0,5+/-0,2	0,5+/-0,2	0,5+/-0,2	0,5+/-0,2
Maxilla non PS**	*3i* ext. hex.	42	0,9+/-0,3	1,0+/-0,3	1,0+/-0,3	1,1+/-0,3	1,2+/-0,3
Mandible non PS	*3i* ext. hex.	43	0,8+/-0,2	0,9+/-0,3	0,9+/-0,3	1,0+/-0,3	1,0+/-0,3

PS* = Platform switched abutments (narrower)
PS**= Same platform abutment (non- switched)

Tab. 1

vant full text publications have been reviewed for a more detailed evaluation.

Tables have been drawn up using data and findings extracted from relevant studies, further compared and analyzed in view of establishing a final conclusion.

_Results

Table 1
Jomi 2009; 24:103–109
Paolo Vigolo, Andrea Givani
Platform Switched Restaurations on Wide-Diameter Implants: A 5-year Clinical Prospective Study

Result: Statistically significant differences in marginal bone loss have been observed between implants with platform switching (0.6 mm; SD 0.2 mm) and implants with the same abutment platform (0.9 mm; SD 0.3 mm)

Table 2
J Oral Maxilofacial Surg. 2007 Jul;65
M, Fickl S, Zuhr O, Wachtel HC
Peri-implant bone level around implants with platform switched abutments: Preliminary data from a prospective study

Result: The concept of platform switching appears to limit crestal resorption and seems to preserve peri-implant bone levels. Significant differences concerning the peri-implant bone height in PS compared to non PS implants are still evident one year after final restauration.

Table 3
Jomi 2007;22:995–1000
Luigi Canullo, Giulio Rasperini
Preservation of Peri-implant Soft and Hard Tissues Using Platform Switching of Implants Placed in Immediate Extraction Sockets: A Proof-of-Concept Study with 12- to 36-months Follow-up

Result: Post-extractive immediate implants with platform switching can preserve hard and soft tissues and, therefore, may provide better aesthetic outcomes.

Table 4
Int. J Periodontics Restorative Dent. 2008 Aug
Cappiello M, Luongo R, Di Iorio D, Bugea C, Coc-

Type of implant	Baseline mean value of crestal bone height	Bone height at 1 year	Mean bone level change from baseline to 1 year
3i int hex PS	-0.09 mm+/-0.65 mm	-0.22 mm+/-0.53 mm	-0.12 mm+/-0.4 mm
3i int hex non PS	-1.73 mm+/-0.46 mm	-2.02 mm+/-0.49 mm	-0.29 mm+/-0.34 mm
P</=0.0001			

Tab. 2

No. of implants	Type of implants	Site of implantation	Mesial Mean bone loss	Distal Mean bone loss	Overall Mean bone loss
9	Defcon Implant System	Maxilla	0.57 mm (0.002–1.02)	1.01 mm (0.230–1.592)	0.78 +/- 0.36

Tab. 3

	Nr. of implants	Bone loss after 1 year	Mean bone loss
PS implants narrower healing abutment	75	0.6 mm–1.2 mm	0.95 mm+/- 0.32 mm
Non PS implants with Same diam. Ha	56	1.3 mm–2.1 mm	1.67 mm+/- 0.37 mm

Tab. 4

chetto R, Celletti R.
Evaluation of Peri-Implant Bone loss around platform-switched implants

Results: This data confirm the important role of the microgap between the implant and abutment in the remodeling of the peri-implant crestal bone. Platform switching seems to reduce peri-implant crestal bone resorption and increase long-term predictability of implant therapy.

Table 5
J Periodontol. 2001 Oct
Hermann JS ,Schoolfield JD, Schenk RK, Buser D, Cochran DL
Influence of the size of the microgap on crestal bone changes around titanium implants. A histometric evaluation of unloaded non-submerged implants in canine mandible.

Results: All implants in the non-welded group had significantly increased amounts of crestal bone loss compared to the welded group. These findings demonstrate that crestal bone changes around 2-piece non-submerged titanium implants are significantly influenced by possible movements between implants and abutments, but not by the size of the microgap. Significant crestal bone loss occurs in 2-piece implant configurations even with the smallest-sized microgaps (<10 micron) in combination with possible movements between implant components.

Table 6
JOMI 2006; 21:777–784
Michael R. Norton
Multiple Single-Tooth Restaurations in the Posterior Jaws: Maintenance of Marginal Bone Levels with Reference to the Implant-Abutment Microgap

Results: The way in which bone responds around an implant may be due to multiple factors. It is also plausible that the tight conical joint, with its high resistance to bending moments and a microgap of only 2–4 microns, contribute significantly to the maintenance of marginal bone.
With an overall mean marginal bone loss of only 0.65 mm from the microgap the data of this study is in close agreement with numerous studies on the Astra Tech System.

The finding that some of the implants have demonstrated bone above the level of the microgap cast doubt on the theory of biologic width, with regard to the influence of the location of the implant-abutment microgap which requires re-evaluation._

Editorial note: The publication will be continued with Part II in the next issue.

Type of implant	Size of the micrograp	Mean crestal bone levels after 3 months*
Laser welded A	< 10 micron	1.06 mm+/- 0.46 mm
Laser welded B	~ 50 micron	1.28 mm+/- 0.47 mm
Laser welded C	100 micron	1.17 mm+/- 0.51 mm
Abutm. with screw D	< 10 micron	1.72 mm+/- 0.49 mm
Abutm. with screw E	~ 50 micron	1.71 mm+/- 0.43 mm
Abutm. with screw F	100 micron	1.65 mm+/- 0.37 mm

Tab. 5

Site	No. of implants (173) Astra	Mean marginal bone loss	Two stage surgical protocol	Transmucosal surgical protocol
Maxilla	80	0.56 mm	48	125
Mandible	93	0.70 mm		

Tab. 6

_contact implants

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