

The new bone level implants – clinical rationale for the development and current indications for daily practice

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Introduction

The use of osseointegrated dental implants in oral rehabilitation has become a standard of care in daily practice. This development was initiated more than 40 years ago in fully edentulous patients (Adell et al. 1981). Since the mid-1980s, osseointegrated implants have been increasingly used and documented in partially edentulous patients (Buser et al. 1990; Lekholm et al. 1994; Buser et al. 1997; Weber et al. 2000; Behneke et al. 2002). With the expansion of implant therapy into partially edentulous patients, implant manufacturers had to modify implant shapes and components to accommodate implants in specific clinical situations. The resulting designs were mainly driven by anatomical considerations related to the implant itself, whereas prosthetic aspects mainly influenced the development of implant abutments and other components.

The Straumann Dental Implant System (Institut Straumann AG, Basel, Switzerland) is scientifically one of the best documented implant systems and has been based to date on tissue level implants (TLI), most of them

featuring a two-part implant design. This development was initiated in the mid-1980s with the design of hollow-cylinder, hollowscrew and solid-screw implants (Sutter et al. 1988a; Sutter et al. 1988b). Following several years of clinical documentation, after the first ITI Consensus Meeting in 1993, Straumann and the ITI Development Committee decided to focus further developments mainly on solid-screw implants, since this specific implant shape showed excellent clinical performance in patients (Buser et al. 1997). In consequence, new screw-type implants were developed alongside the standard screw implant to comply with increasing demand for optimal treatment of various well defined clinical situations in partially edentulous patients.

These additional implant types included the diameter-reduced, wide-body and wide-neck implants. All of these implants had in common a neck portion with a machined surface of 2.8 mm in height to locate the implant shoulder close to the mucosal surface. For esthetic sites, these implant types were modified and offered as a “plus” version with a shorter, 1.8 mm machined neck configuration. This esthetic implant line was later expanded with the narrow-neck and the TE implant (Figure 1). To improve esthetic outcomes, these implants featuring a short, 1.8 mm machined neck had to be inserted with their shoulder close to the bone crest to allow a submerged or semi-submerged healing and to avoid a visible metal collar following restoration (Buser and von Arx 2000; Buser et al. 2004) offering good clinical outcomes (Belser et al. 1998; Giannopoulou et al. 2003).

This implant insertion technique was similar to standard surgical techniques used for Brånemark-type implants, and caused increased bone

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resorption in the crestal area (Figure 2). Based on experimental and clinical studies, this bone resorption is much better understood today (Hammerle et al. 1996; Cochran et al. 1997; Hermann et al. 1997). This physiologic bone resorption amounts to approximately 2 mm following restoration, which is routinely seen in radiographs on the mesial and distal aspect of the implant (Figure 3). This interproximal bone resorption does not cause esthetic problems in the papillary area, as long as the bone height is not compromised at adjacent teeth (Choquet et al. 2001). Such bone resorption is often termed bone “saucer” and is a circumferential phenomenon (Fig. 4) meaning that bone resorption also takes place on the facial aspect of the implant (Buser et al. 2004; Grunder et al. 2005). This can cause an esthetic complication with soft tissue recession on the facial aspect, if the implant shoulder is positioned too far apically or too far facially (Buser et al. 2004, Evans and Chen 2008).

Development of improved implant designs to reduce crestal bone resorption

Efforts have been made for years to reduce crestal bone resorption. One development with scalloped implants did not fulfill high expectations (Nowzari et al. 2006). Another development related to the “platform switching concept” was accidentally discovered and has heavily influenced implant dentistry in the past five years (Lazzara and Porter 2006).

More than six years ago, a task force was established by Straumann to develop a new bone level implant based on the platform switching concept. Beside various Straumann specialists, the working group also included Urs Belser, Daniel Buser and David Cochran from the ITI to provide clinical expertise for the development. After two years of intensive in-vitro testing of various prototypes, pre-clinical and clinical studies were initiated to evaluate the new BLI in its currently available form. Some of these studies have been published in the meantime confirming the high potential of this new implant type (Jung et al. 2008; Buser et al. 2009). It was hypothesized that this implant offers minimal peri-implant bone resorption following restoration, which is important for single tooth implants on the facial aspect, and for adjacent implants to better maintain the bone level in the interimplant area. In addition, the location of the implant platform at the bone level offers the clinical

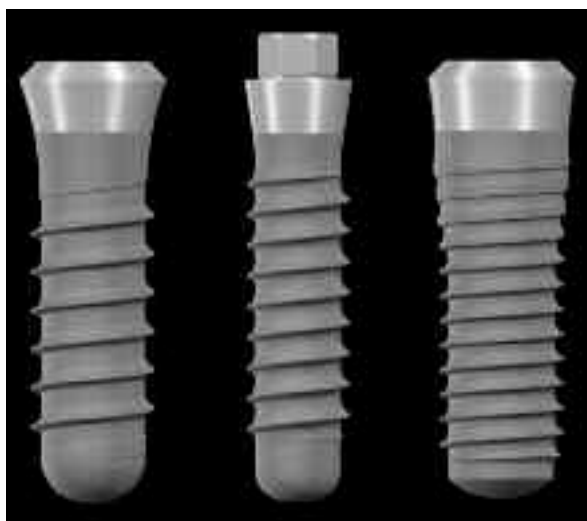


Figure 1: Straumann tissue level implants with a short 1.8 mm neck configuration have been mainly utilized in esthetic sites (from left): The standard plus, the narrow neck and the TE implant.

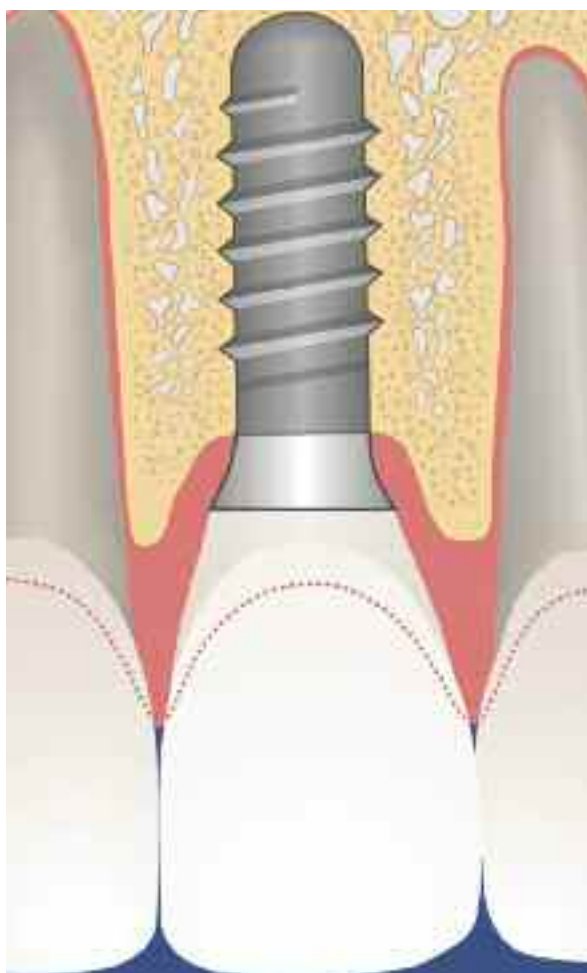


Figure 2: Implant placement of a standard plus implant in an esthetic site routinely caused a typical bone saucer in the crestal area which measures around 2 mm in the vertical direction and at least 1 mm in the horizontal direction.

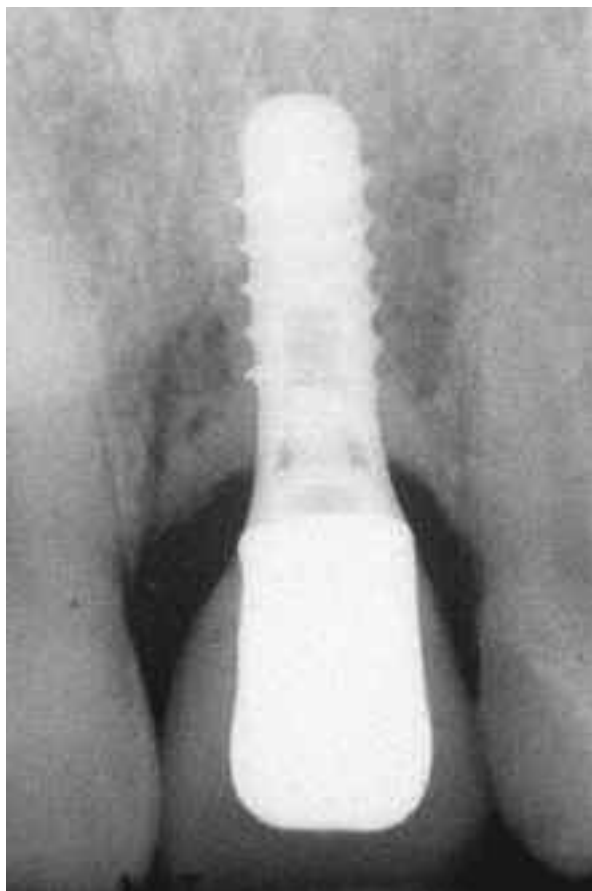


Figure 3: Radiographic documentation of a typical bone saucer around a standard plus implant ten years following implant placement. The peri-implant bone is in a steady-state.

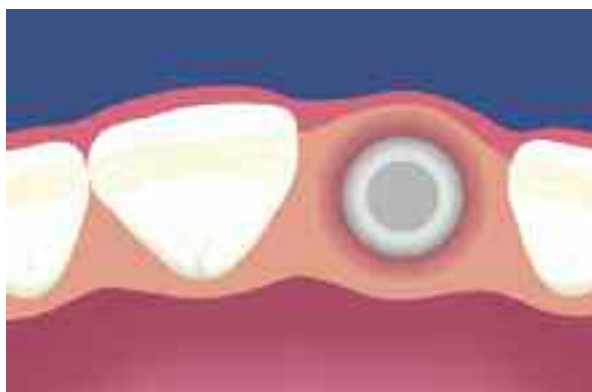


Figure 4: Diagram illustrating the circumferential bone saucer, which routinely develops around tissue level implants in esthetic sites. Critical is the bone resorption on the facial aspects, since this can cause a mucosal recession.

advantage of selecting the abutment height according to the local soft tissue characteristics and thickness. Thus, the clinician benefits from a clearly increased versatility.

Clinical Indications of Bone Level Implants

The new BLI has the same endosseous shape as the TE implant, but with a cut-off neck configuration (Figure 5). Consequently, a new abutment connection had to be developed and it took time and effort to find an ideal solution. Finally, the new CrossFit connection (Figure 6) was chosen by Straumann, which offers the clinician easy touch-and-feel handling during impression taking and abutment insertion. The new BLI is currently available in three different diameters (Figure 7) and offers a wide range of prosthetic components. They are not intended to replace tissue level implants, but to complement them for specific clinical situations. The selection criteria of when to use which implant type will vary from clinician to clinician based on personal preference. Based on the above mentioned advantages of BLI, it is clear that they will be used predominantly in esthetic sites, since they help the clinician to better preserve important peri-implant bone structures in the crestal area while allowing abutment heights to vary. Both aspects optimize esthetic outcomes.

An important indication will be the single tooth replacement following extraction in the esthetic zone. Thus, this indication was selected for the first clinical study to evaluate BLI (Figures 8a, b). The prospective case series study examined BLI with a diameter of 4.1 mm in 20 consecutive patients. The implants were inserted following an eightweek soft tissue healing period using the concept of early implant placement and simultaneous contour augmentation with the GBR technique (Buser et al. 2008, Buser et al. 2009). Particular emphasis was placed on the correct three-dimensional positioning in the mesio-distal, oro-facial and coronoapical direction. Compared with tissue level implants, BLI are inserted according to the same basic principles (Buser et al. 2004) with one exception: BLI are inserted roughly 1 mm more apically. It is recommended to position the implant shoulder approximately 3 mm apical to the desired soft tissue margin at the future implant crown mid-facially (Figure 8c).

The one-year results showed good to excellent esthetic treatment outcomes, objectively evaluated with the esthetic PES (Pink Esthetic Score) and WES (White Esthetic Score) indices (Belser et al. 2009). Bone loss was minimal with a mean DIB value of only 0.18 mm. Only one out of 20 implants showed more than 0.5 mm bone loss (Figure 9).

At present, most of the two-year follow-up examinations have been performed, but a few are still missing. So far, the clinical and radiographic examinations



Figure 5: The new bone level implant has the same endosseous shape as a TE implant.



Figure 6: Bone level implants are also characterized by a new abutment connection, the CrossFit™ connection.



Figure 7: Bone level implants are currently available in three different shapes with diameters of 3.3, 4.1, and 4.8 mm (from left to right).

indicate good stability of the peri-implant tissues (Figures 8d and 8e). Based on positive clinical experience with single tooth implants, the indication for BLI was expanded in mid-2006 for sites with two missing central incisors to be used for adjacent implant placement. The clinical experience with roughly 20 patients indicates good bone stability between the implants (Figures 10 a–c), but this is a preliminary observation and needs to be confirmed by a mid-term radiographic analysis. In 2008, an additional indication was addressed, namely the single tooth replacement in lateral incisor sites in the maxilla utilizing the 3.3 mm diameter BLI (Figures 11a–b). However, no published data is available yet for the narrow diameter BLI. Currently, we have also started to use BLI in extended edentulous spaces in the anterior maxilla with more than two missing teeth.

In posterior, non-esthetic sites, tissue level implants continue to be predominantly utilized in daily practice. In fact, the clinical experience of more than 22 years with two part tissue level implants has clearly demonstrated the advantages of a restoration implant interface located in the vicinity of the soft tissue surface. With this implant shoulder location, restorative procedures are similar to conventional crown and bridge prosthetics, and thus easy to control by the clinician.

In this context, one should mention the design simplicity of cemented crowns and short-span fixed dental prostheses (FDP). In addition, the maintenance of peri-implant tissue health is easy to accomplish by patient's routine oral hygiene measures. In posterior

sites, potential indications for BLI are sites with a limited mesio-distal space of less than 7 mm in the premolar area, where a regular neck implant cannot be utilized. The smaller coronal platform of BLI makes it possible to avoid the approximal danger zone in such situations (Figures 12 a–d).

In addition, situations with a limited vertical space from the implant platform to the occlusal plane might be better suited to BLI.

From a surgical point of view, the utilization of BLI can be an advantage in osseous defect sites requiring large augmentation volumes, since the implant has less volume in the crestal area and facilitates an easier application of bone fillers and of barrier membrane. This in turn allows for easier, more tensionfree primary wound closure (Figures 13a–j).

Conclusions

The new bone level implants are a most welcome extension to the existing tissue level implants of the Straumann Dental Implant System. The clinical experience of more than three years clearly confirmed the expected minimal bone resorption at the implant shoulder in patients with single tooth replacements. The results of a prospective case series study also demonstrated favorable esthetic treatment outcomes as documented by the PES-WES Index. Although the clinical experience with two adjacent implants in the anterior maxilla is still limited, the preliminary results are very promising. Currently, BLIs are clinically tested in additional indications such as posterior sites with large



Figure 8a: Female patient with a root fracture of tooth 11 and increased probing depths. The contralateral tooth 21 demonstrates a gingival recession. Tooth 11 has to be extracted and replaced with an implant borne crown. The concept of early implant placement will be utilized.



Figure 8b: Status eight weeks following extraction. The extraction site shows a typical flattening in the middle of the socket.



Figure 8c: Intraoperative view demonstrating a correct coronal-apical positioning of the implant: Mid-facially, the shoulder is located roughly 3 mm apical to the future mucosal margin of the implant crown. The peri-implant bone defect is augmented with the GBR technique.



Figure 8d: Clinical status at the two-year follow-up examination. A pleasing esthetic outcome is noted with stable soft tissues at the implant-supported crown. Please note a minor incisal step between the two central incisor crowns indicating a slight growth of the alveolar process.

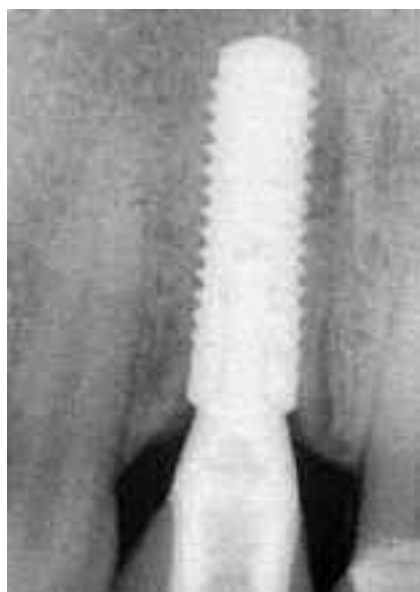


Figure 8e: Periapical radiograph at the two-year examination exhibiting the bone level implant with no crestal bone loss.

bone augmentation procedures or in sites with limited mesio-distal or vertical space. The next two to three years will show in which indications BLIs offer particular advantages or benefits, and thus will be preferred over tissue level implants.

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Figure 9: Radiographic observation at the 12-months examination of 20 consecutive patients. No or less than 0.25 mm bone loss was noted in 15 patients. Four patients showed a bone loss of 0.25 and 0.5 mm, whereas one implant (5%) exhibited a bone loss of 0.76 mm (Buser et al. *J Periodontol* 80:152, 2009).



Figure 10a: 45-year old female patient with two missing central incisors caused by traumatic tooth fracture. Both fractured roots are still in place in the edentulous area. Implant placement with simultaneous contour augmentation using GBR is planned.



Figure 10b: Clinical status nine months following implant placement with simultaneous GBR. After a soft tissue conditioning phase with provisional crowns, both implants were restored with full ceramic crowns. The esthetic outcome, including the central papilla, is pleasing.

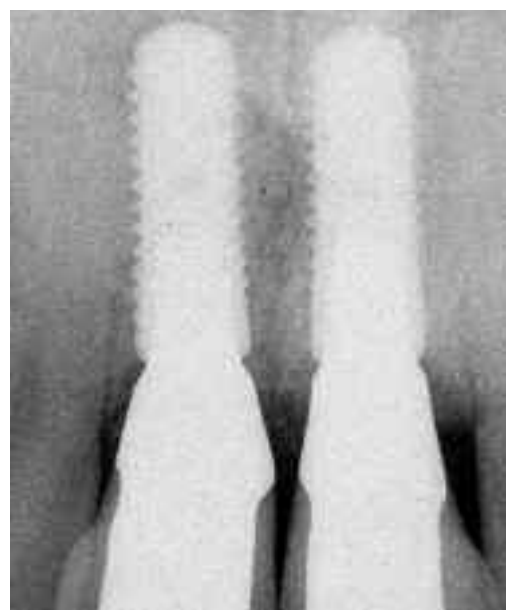


Figure 10c: The periapical radiograph at nine months confirms stable bone crest levels and shows no indication for bone loss around and between the two implants.

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Figure 11a: Single tooth gap with a missing lateral incisor in the right maxilla. The mesio-distal gap size measures roughly 6 mm and requires a narrow diameter implant.



Figure 11c: Clinical status nine months following implant placement with simultaneous GBR and restoration with an all-ceramic crown. The soft tissue esthetic outcome is pleasing.

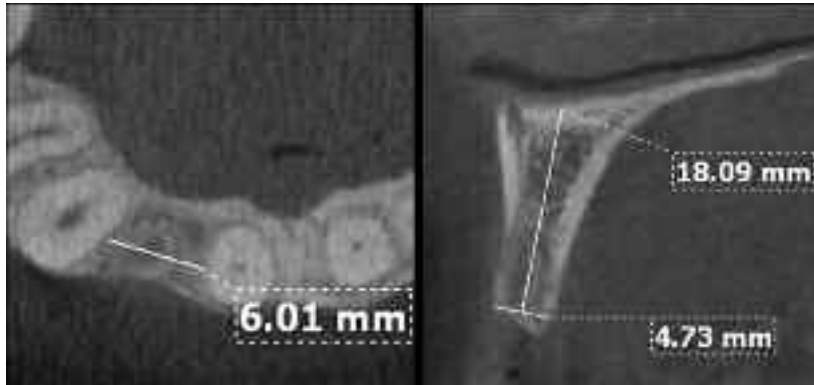


Figure 11b: The cone-beam tomography illustrates the single-tooth gap with just 6 mm mesio-distal space and a reduced crest width of less than 5 mm. This requires a simultaneous contour augmentation using the GBR technique.

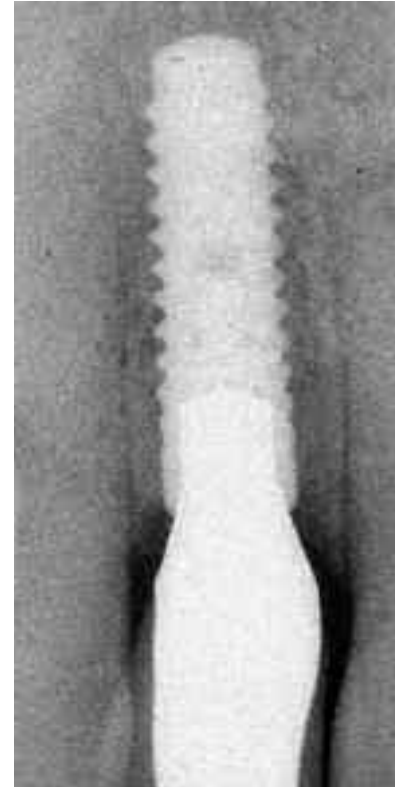


Figure 11d: The periapical radiograph demonstrates the 3.3 mm bone level implant with stable peri-implant bone levels.



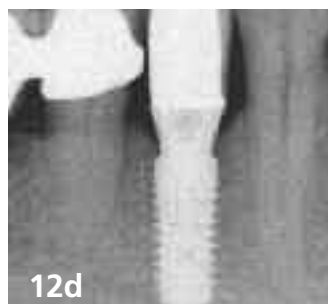
Figure 12a: Missing first premolar in the mandible with a reduced mesio-distal gap size of less than 6 mm at the level of the contact points. Status during insertion of a bone level implant (BLI 4.1 mm).



Figure 12b: The BLI was inserted slightly subcrestally on the mid-facial aspect. A 2 mm healing cap was inserted.



12c



12d

Figure 12c: Clinical outcome following restoration with a single crown, which is clearly smaller in size than the adjacent second premolar.

Figure 12d: The periapical radiograph at five months of follow-up shows no obvious bone loss around the bone level implant.



Figure 13a: 60-year old female patient with a distal extension situation. Status six weeks following extraction of teeth 35, 36 and 37.



Figure 13b: The periapical radiograph exhibits the edentulous area in the posterior mandible. The extraction sockets are clearly visible.



Figure 13c: Status following implant placement of two bone level implants and insertion of 2mm healing caps. The peri-implant bone defects require local bone augmentation with GBR.



Figure 13d: The defects have been augmented with locally harvested autogenous bone chips and DBBM to the level of the healing caps.



Figure 13e: The augmentation material was covered with a resorbable collagen membrane.



Figure 13f: Implant surgery was completed with a tensionfree primary wound closure. This is easier to achieve compared with tissue level implants, since less volume in the crestal area needs to be covered.



Figure 13g: Primary soft tissue healing was uneventful for eight weeks.



Figure 13h: The reopening procedure was performed with a mid-crestal incision and insertion of longer healing caps. The wound margins with keratinized mucosa were adapted and secured with interrupted single sutures.



Figure 13i: Clinical status six months post placement: Both implants were restored with two splinted single crowns.

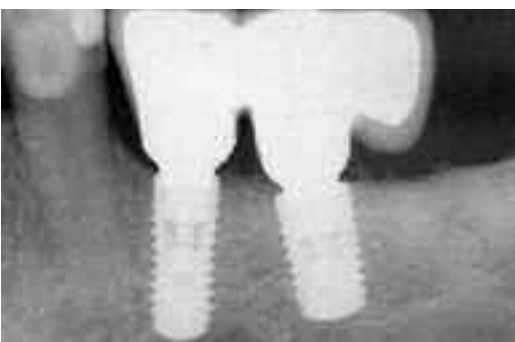


Figure 13j: The corresponding radiograph demonstrates the 10 and 8 mm long BLI restored with two splinted single crowns. No bone resorption is visible around both implants.

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