Innovative dental implant design shows improved success rate, bone stability and esthetic benefits

A retrospective study over 3 years including 2-year follow-up

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ABSTRACT

Objective: The aim of this research is to retrospectively evaluate an innovative implant and prosthetical design by applying the following criteria: 1. implant success rate, 2. bone loss and stability of bone level at the collar of the implant, 3. esthetics in terms of pink esthetic score, 4. thickness of the gingiva at 3 mm from the free gingival margin, 5. width of the keratinized gingiva around implants, 6. height of the gingiva around the implants

Material and methods: The study is comprised of the data of 137 patients with 608 implants (C-Tech, Bologna, Italy). 56 of them were included in a 2-year follow-up for assessing success. In addition, 82 were examined after 18 months to give a total of 138 implants for which we have a 18 months recall. Furthermore, the PES (Pink Esthetic Score), gingiva width (of the keratinized tissue), gingiva depth, sulcus depth and bone loss (mesial/distal) were collected from 42 implants.

Results: Only two implants were lost (after 6 months), both relating to a single patient. The success rate for those included in the 6-months, 12-months, 18-months and 24-months was 100 percent. Bone loss was not found in any participant of the study. The soft tissue scores indicated a highly esthetic result.

Conclusion: The implant system employed in the present study showed high success rates both for the stability in situ and for the esthetic aspects. Therefore, within the scope of the data collected it may be recommended for use in the population at large.

INTRODUCTION

Implant success today consists of more than just “osseointegration accomplished”. We also have to take into account the esthetic result. The esthetic success will be assessed by measuring a stability of the volume (bone/soft tissue around implants) as well as the symmetry, colour, structure and form of the periimplantary tissues. It will be evaluated by the Pink Esthetic Score (PES) and the White Esthetic Score (WES) (1). Both of them depend on the implant position, the implant design, the bone volume, the soft tissue thickness around the implants and the stability of the tissues. These parameters may change over the years.

Implant system

The characteristics of the implant system used in the retrospective study (C-Tech, Bologna, Italy) were developed to suit today’s requirements as outlined hereinbefore. The most important details are given in the following.

Fig .1: innovative C-Tech implant design

The *implant design* has a beveled shoulder with a rough surface (2, 3). The implant is meant to be inserted under the level of the bone, therefore bone will cover the shoulder of the implant and thus grow in any clinical situation given (4). The insertion protocol includes a stop system ensuring that the implant is inserted 1 mm below the bone level. This detail should be considered already in the implant planning phase.

The entire implant surface has a microroughness of 150-300 microns achieved by sandblasting with titanium oxide and acid etching (SLA method). This gives, as a general rule, a sufficient level of BIC (bone implant contact surface) (5).

Micro-thread design at the collar avoids the cortical bone loss (6). A sophisticated self-cutting thread macro-architecture (thread in thread and groove in groove, fig. 1) ensures an appropriate cutting performance, at the same time preserving the bone structure. A double lead threading design facilitates a bone-protecting timing of the insertion. In addition, the thread in thread and groove in groove architecture results in an enlarged BIC.

Platform switching design is proven to avoid bone loss around implants [0.6 mm instead of 1.4-1.6 mm, as is documented for implants with no platform switching (7, 8, 9, 10, 11)]. The platform switching design details have a beneficial effect on the height of the periimplantary bone, but also on the height of the soft tissue, which is more appropriately denominated “the dento-gingival complex” (fig. 2).

Fig. 2: platform switching concept

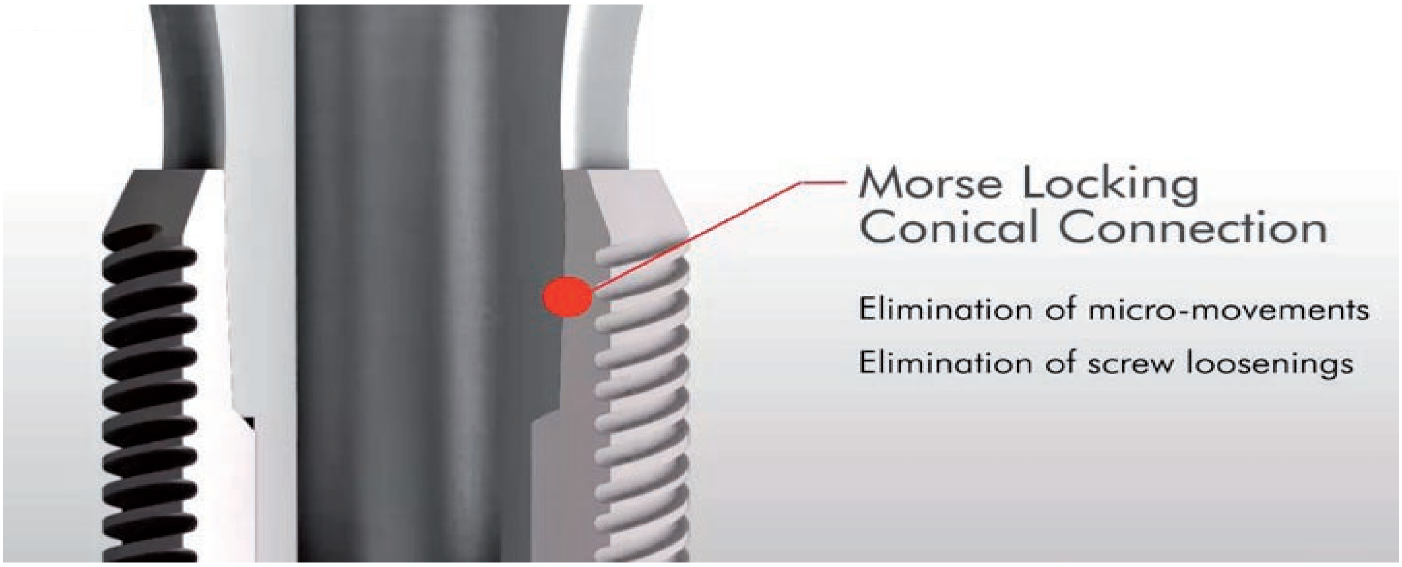


Fig. 3: Morse tapered conical connection

The *Morse tapered conical connection* (fig. 3) is proven to be the most stable connection at the present time. Therefore, some implant systems have already started to implement it, and they have proved the stability of the bone level using this connection (Bicon, Ankylos).

Scientifically it has been proven that the micro-movements, rather than the size of the microgap, are the reason for bone loss (Hermann et al.). Normally, the microgap in implant connections has been reported to range between 21 and even 60 micrometers, which allows for the accumulation of bacteria, local inflammation and bone loss.

The Morse conical connection, which is familiar in the aerospace industry as „cold welding connection", is characterized by the technical detail that the angle between the inner angle of the implant and the connections is less than 25 degrees. The microgap is smaller (1.1-1.5 micrometer) than a bacterium (2-6 micrometer) (12). Therefore, it is the most stable connection known until now, in association with the least screw loosening (0.37%) (13).

Apart from that, it has a high bending stability at shear tests under 800 N at 30 degree (14).

Gargiulio proved in his article in 1980 that the thicker the tissue above an implant > 4 mm the less bone loss will occur after the uncovery. The reason is the formation of the biological width which needs ca. 3 mm to exist. In thin tissue biotype (< 2 mm) the biological width will be built at costs of the bone loss.

Linkevicious (15) showed in a recent article that, even if implants with platform switched design were used, there will be a bone loss if the tissue typology is thin. Therefore, the surgical procedure will always include the changing of the soft tissue biotype with CTG (connective tissue graft) or membranes before the surgery or during the surgery.

More and more studies and clinical observations are showing that a concave profile of the running room creates a higher and thicker volume of the periimplant tissue (16), maintaining it also in the long run (17) (fig. 4, 5, 6).

Fig. 4-6: Concave profile of the running room of the provisional, healing, impression or final prosthetic parts:

Fig. 4: Healing abutment with concave running room

Fig. 5: Provisional abutments/impression abutments with concave profile (concave running room)

Fig. 6: Final abutments with concave profile (concave running room)

Implant position

A correct implant position makes an esthetic outcome predictable. The implant should be positioned in an esthetic zone and an extraction socket, 2-4 mm from the buccal plate (11), 2-3 mm below the cement enamel junction (12) or 4 mm from the gingival margin that we want to achieve. Buccopalatally, the implants were inserted 2-4 mm from the buccal plate. Every gap was grafted.

Immediate implant placement and immediate loading

202 cases were immediate implant placement, 205 immediate loading. All Implants had at least 30 Ncm primary stability at the time of insertion, thanks to the cutting performance of the implant and the insertion protocol including a last drill with a diameter slightly smaller than the diameter of the implant. The conditions to load an implant inserted in an extraction socket were: primary stability, 3/4 of the surface will be covered by bone, and the rest of the defect will be grafted with the rules illustrated below (18).

Grafting procedures

The materials used for the simultaneous grafting of the socket or defect were: either ßTCP+HA in 60/40 proportion, or a bovine hydroxylapatite. The membranes used were: collagen membranes with long resorption time, non-chemically crosslinked for a protection of the graft. Some of the membranes (Mucoderm/Botiss) were used to additionally increase the tissue biotype. The rules of grafting are illustrated in the following table.

Prosthetical treatment

All cases were treated in a similar way, including a concave abutment profile of the provisional abutment, a concave abutment profile of the final abutment (prefabricated) or, in cases with high esthetic demand, a slightly convex profile to build up the periimplantary papilla. The prosthetics included various embodiments, e.g., 13 full-arch restorations.

EXAMPLE OF A CLINICAL CASE WITH HIGH ESTHETIC DEMAND

The clinical case shown below is related to a 65-year-old female patient included in the study. She presented with a partially edentulous situation, all teeth having mobility grade 2 (fig. 7). All teeth in the upper jaw were extracted, an immediate extraction and immediate loading procedure was planned. The case was illustrated to the patient by photos, and a digital planning of the teeth was performed according to the DSD software principle. A provisional was fabricated based on the wax-up, which was inserted immediately after the implant placement.

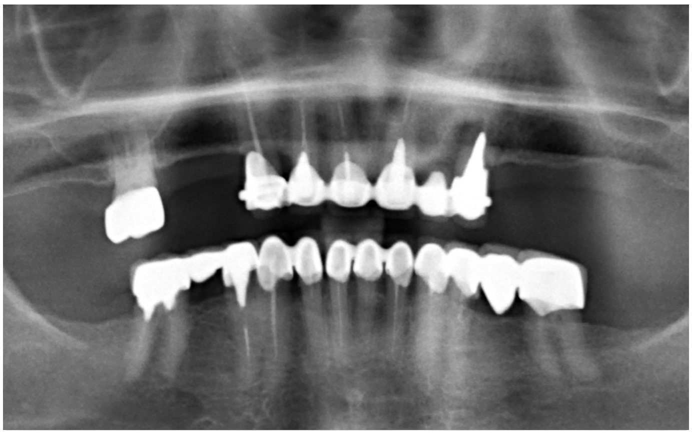


Fig. 7: Pre-OP situation

The implants were inserted in the palatal wall of the alveola in a perfect 3-dimensional position, under the bone level, in a distance of 2-4 mm from the buccal plate. All implants had primary stability of 35 Ncm.

Immediate implant placement	Thick tissue biotype	Thin tissue biotype	
ideal	no flap gap grafting IIP IL	gap grafting, soft tissue MI grafting IIP No IL	
less buccal plate	hard and soft tissue grafting IIP	hard and soft tissue grafting IIP NO IL	
no buccal plate	sandwich technique IIP, NO IL	sandwich technique, NO IL	
no interdental bone	hard and soft tissue grafting, staged surgery	hard and soft tissue grafting, staged surgery	

Table 1: Simultanuous grafting with implant placement. IIP=immediate implant placement; MI=minimally invasive; IL=immediate loading

Fig. 8-26: Typical protocol as used in the present study

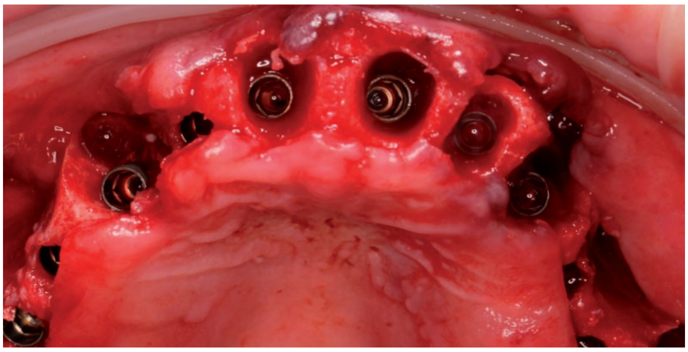


Fig. 8: Implants in position

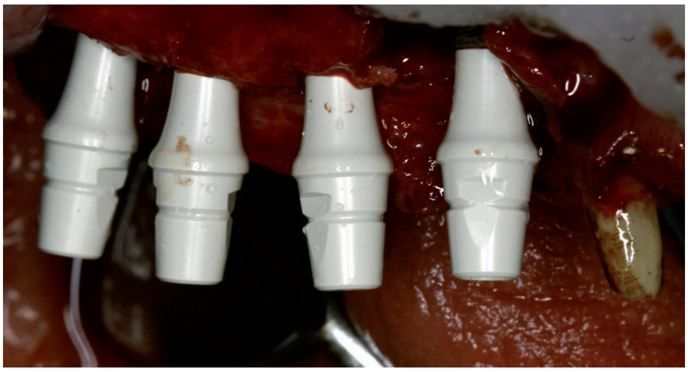


Fig. 9: Provisional Abutments with 6 mm height of the concave running room.

There were buccal defects which were grafted adequatly with ßTCP and HA (Maxresorb, Botiss) and Osgide (Curasan). Vertical defects were grafted with the help of the sonic weld technique (KLS Martin).

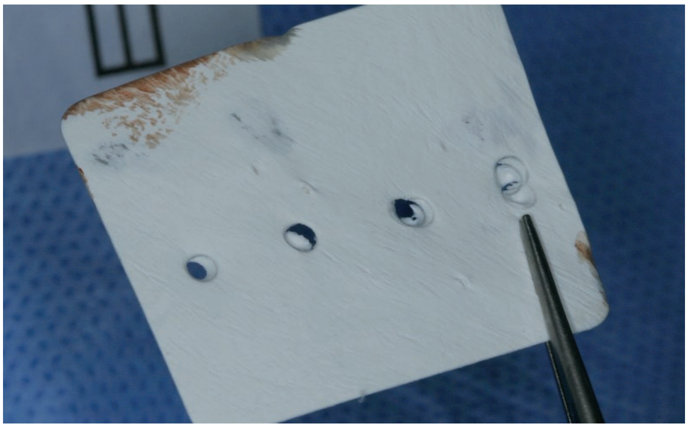


Fig. 10: Collagen membrane will be perforated for overlapping the grafting buccally and palatally.

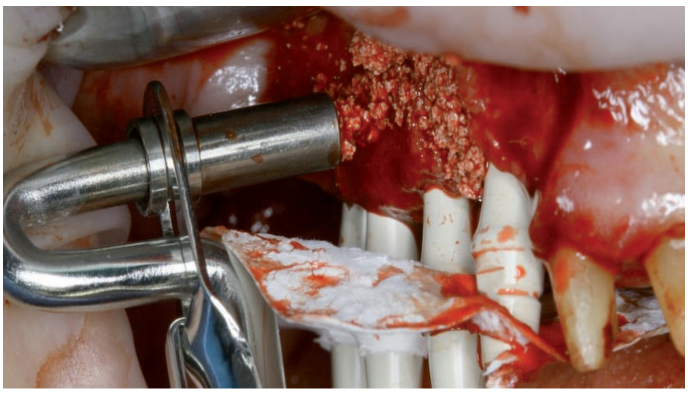


Fig. 11: The particulate material is applied.

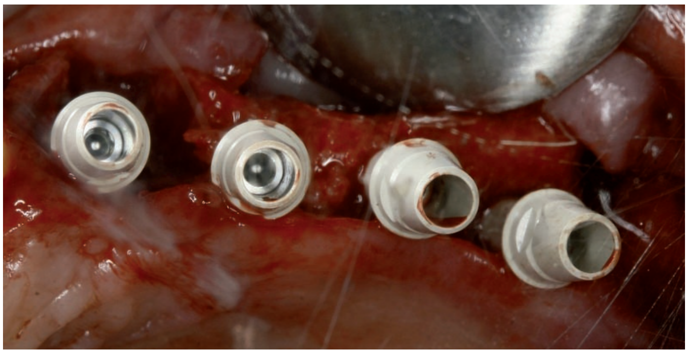


Fig. 12: The positions of the implants are the first precondition for a predictable esthetical outcome.

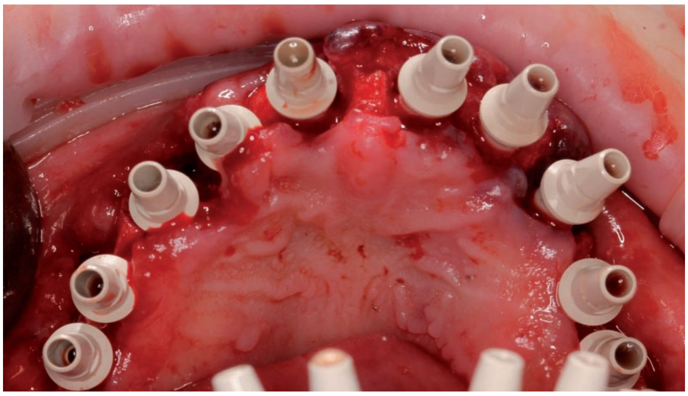


Fig. 13: All implants in situ.

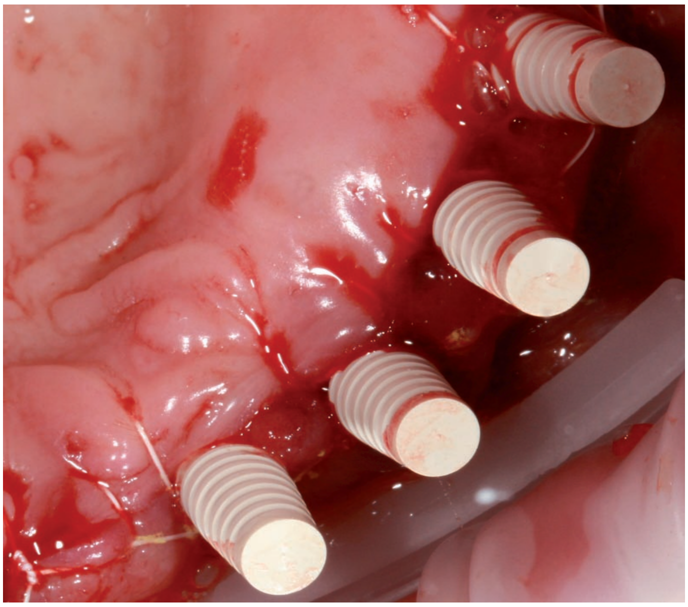


Fig. 14: Provisional „Snap-on caps"

Fig. 15: The caps are made, as well as the provisional abutments, out of PEEK (polyether ether ketone). Thanks to their snapping mechanism, they need very little provisional cement for fixation. They will be polymerized directly, in the mouth, in the surgical session, into the provisional prepared in advance.

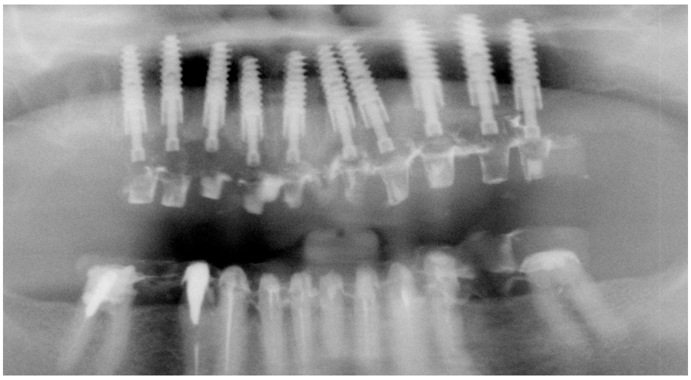


Fig. 16: Situation after inserting the implant and incorporating the provisional bridge

Fig. 17: Provisional bridge in situ

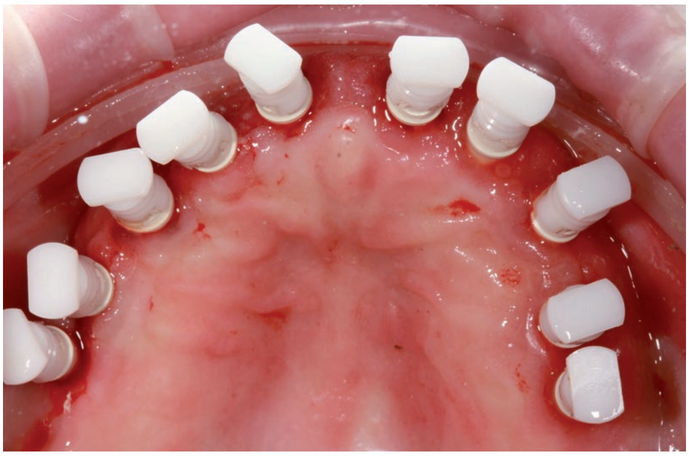


Fig. 18: After the osseointegration, the same provisional abutments will be used for taking impression with the impression caps. The provisional abutments are not even removed in between, thus reducing the number of removal of components which leads directly to reducing bone loss and conserving the tissues.

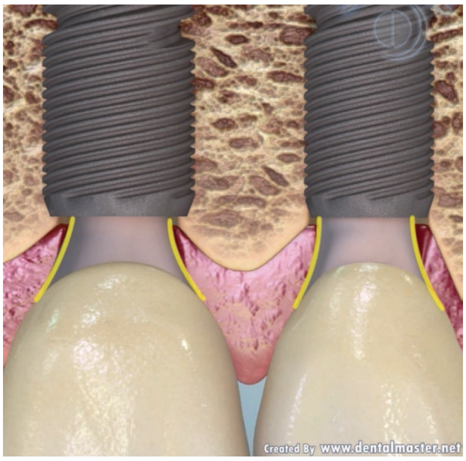


Fig. 19. The platform switching design provides for less bone resorption between the implants. The provisional abutment with a concave running room allows for suitably constituting the soft tissue having a thicker structure around the collar.

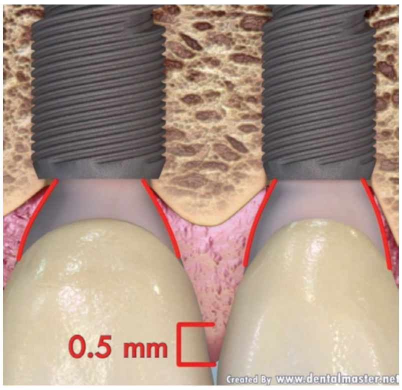


Fig. 20: The option for the final abutment will be to keep the concave shape exactly the same, using eventually the very same abutment shape, with the same collar height. It will be prefabricated out of Titanium.

If we have to treat the esthetic zone, where the symmetry of the papilla should be perfect, a slightly convex profile of the individual abutment will be employed.

Fig. 21: These zirconia or lithium disilicate individual abutments will be made in a way that the preparation margin will be positioned 0.5 mm under the gingival zenith of the future marginal gingiva.

Fig. 22: On the model: dental work fabricated of lithium disilicate ceramics (e.max, Ivoclar Vivadent, Schaan).

Fig. 23: Dental work in the patient's mouth: gingival adaptation on the lithium disilicate crowns 4 weeks after placement.

Fig. 24: The satisfied patient

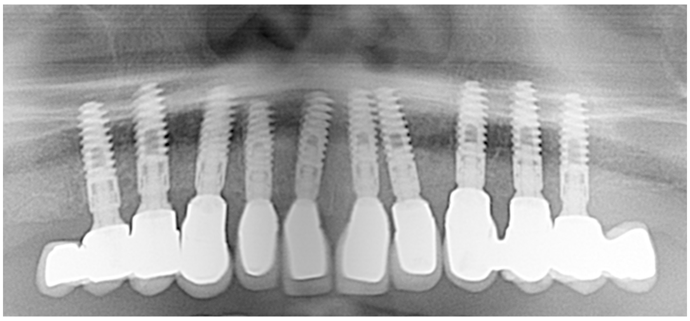


Fig. 25: Radiologic control after insertion. Note the level of the bone around the implants.

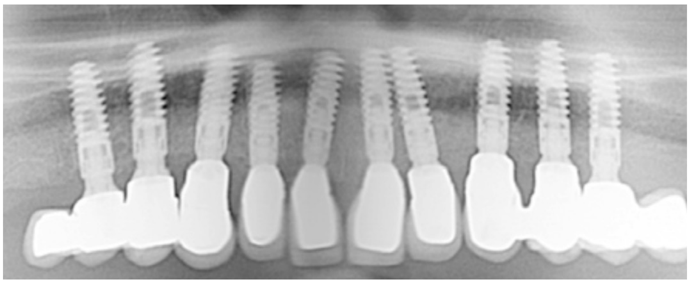


Fig. 26: Radiologic control 1 year after insertion. The level of the bone is stable – no bone loss. The bone keeps covering the shoulder as it had initially.

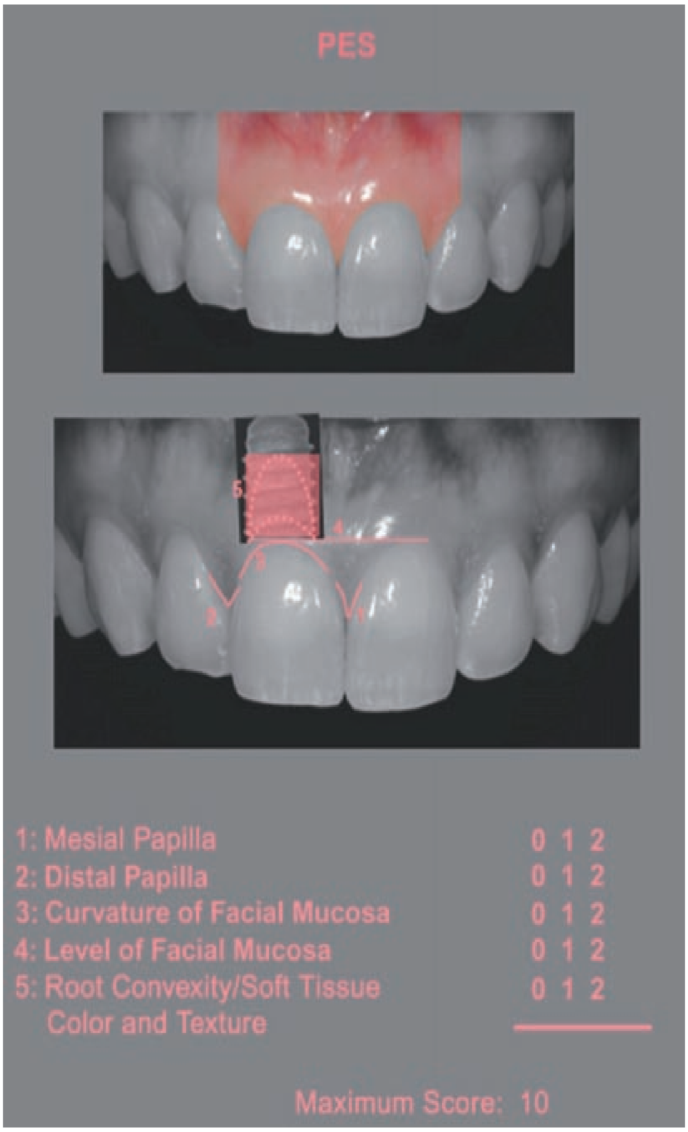
This study uses an innovative implant and prosthetic concept enabling the practitioner to create and stabilize the periimplantary bone and gingival complex. This implant design and treatment concept seems to allow for a better esthetic result in situations with adjacent implants.

CLINICAL STUDY

METHODS

137 patients were included in the study and provided with 608 implants. Implants with diameters of 3.5 mm and 4.3 mm were placed depending on the requirements of the clinical case. In most cases a 3.5 mm implant was employed (79%), and the remainder were 4.3 mm diameter implants. The rehabilitations comprised 13 full-arch restorations. Immediate implant placement cases were included as well as immediate loaded and implants inserted according to a late loading protocol. Both fixed constructions and removable ones were part of the prosthetics.

Follow-up was performed after 6, 12, 18 and 24 months, whenever possible, to give success rates. In addition, the PES (Pink Esthetic Score), gingiva width (of the keratinized tissue), gingiva depth, sulcus depth and bone loss (mesial/distal) were collected. The esthetic success was measured using the PES (Pink Esthetic Score) which is defined as shown in the table below. A score less than 7 indicates suboptimal esthetics.



PES

1: Mesial Papilla	0 1 2
2: Distal Papilla	0 1 2
3: Curvature of Facial Mucosa	0 1 2
4: Level of Facial Mucosa	0 1 2
5: Root Convexity/Soft Tissue Color and Texture	0 1 2
Maximum Score:	10

Table 2: how to evaluate the PES (pink esthetic score)

The width of the keratinized gingiva must be at least 3 mm for a long term stability and esthetic success. The distance measured ran from the muco-gingival line to the zenith of the marginal gingiva at the most convex point.

The thickness of the keratinized gingiva provides us with information on the gingival biotype at 3 mm from the zenith of the teeth. A score less than 1 indicates a suboptimal biotype, i.e. the implant is prone to loss.

The probing depth in case of no bone being lost gives us information about the gingival height, which is depending on tissue biotype. Control of bone loss was performed using an X-ray.

RESULTS

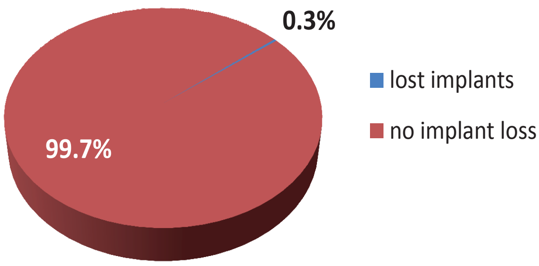
The cumulated success of all implants inserted was near 100 per cent. Only 2 implants were lost both implanted in a single patient in autumn 2013 who was provided with a total of 6 implants. Osseointegration was not achieved for 2 of them. When the provisional was removed during the 6-month followup those 2 implants came out with it. This was probably due to the patient not respecting the soft food diet recommended during the time of bone healing. However, the remaining 4 implants are still in situ.

Apart from this singular case, all other follow-ups resulted in “implant success achieved”. This leads us to a success rate of 100 percent based on both 1-year, 18-months and 2-year timeline (56 implants). Bone loss could not be detected and the bone level at the collar of the implants maintained on a stable level in each follow-up.

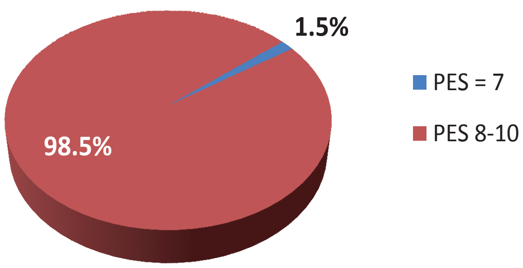
100 % of all the 42 implants examined for gingival parameters had a PES > 8 which is equivalent to good esthetics. Based on the 2-year follow-up, only in three cases a gingiva width < 3 mm was found (7.1 %). No implant evaluated yielded in a gingiva thickness < 1; only 6 were exactly 1 (14.3 %).

Clinical success according to the criteria applied

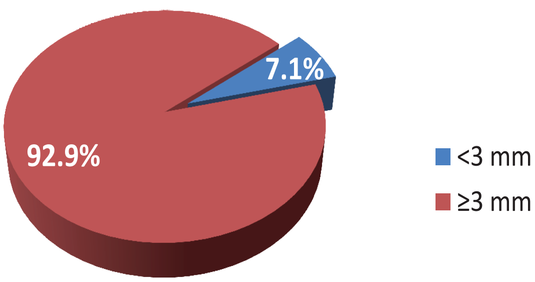
Low implant loss with C-Tech implants (N=608)



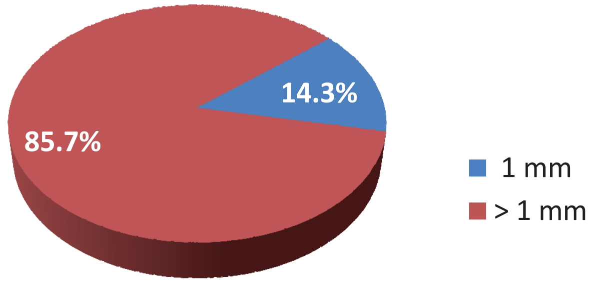
Highly esthetic result with C-Tech implants (N=137)



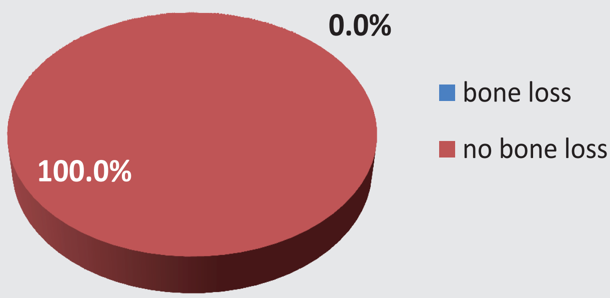
Gingiva width of the keratinized tissue using C-Tech implants



Gingiva depth of the keratinized tissue using C-Tech implants

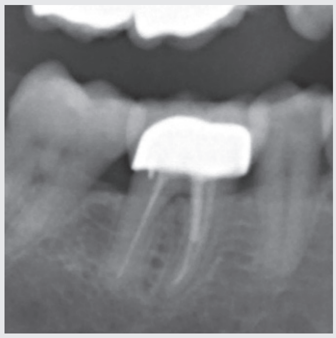


Bone loss around c-tech implants (N=137)

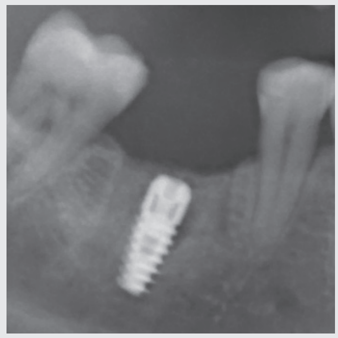


EXAMPLES OF THE IMPLANT BONE STABILITY OVER 2 YEAR PERIOD

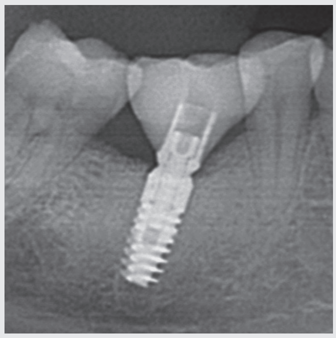
Pre-operative situation



Situation on day of insertion
June 04, 2012



6 MONTHS AFTER
crown placement
June 13, 2013



2 YEARS AFTER
crown placement
September 25, 2014

DISCUSSION AND CONCLUSION

This study uses an innovative implant and prosthetic concept enabling the practitioner to create and stabilise the periimplantary bone and gingival complex, thus achieving a high osseointegration success rate, and a high rate of esthetic success. This is the common target of an implant treatment and the answer to patients' desire.
According to the data presented in this retrospective study the success rates are near 100 % based on the total of 137 patients/608 implants as well as for the 2-year follow-up group (56 implants). Longer term stability and esthetic success studies will be presented in further research.

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