

TOOTH IMPLANT

BACKGROUND OF THE INVENTION

The invention relates to a dental implant with single- or multiple roots, shaped according to the tooth socket or dental root with protruding macro retentions
5 for immediate and delayed tooth replacement.

The established methods of placing dental implants is drilling an implant hole into the bone, inserting the implant into the prepared cavity by tapping and/or screwing. Prefabricated rotation-symmetric implants of varying forms, lengths and diameters require several weeks healing period.

10 The method with preformed rotationally symmetric implants does not work in cases where primary stability cannot be achieved due to incongruence of the tooth socket and the rotation-symmetric implant. In such cases first a bone healing period is necessary, since the incongruence of the tooth socket to the pre-fabricated rotation-symmetric implant does not allow for primary
15 stability. Therefore it is an advantage to design the dental implant according and congruent to the individual extraction socket.

Prior German Pat. No. DE 101 09 118 A disclosed an individually tailored tooth implant based on an exact impression of the extracted tooth, enlarged about twice the distance of the periodontal ligament, provided with grooves
20 and finally fixed into the bone with press-fit.

Prior WO Pat. No. 88/ 03391 disclosed a slightly enlarged root analogue press fit technology implant with undercut cavities, distributed equally over the entire root surface.

Another possible technique described in US Pat. No. 5,603,616 A und US
25 5,427,526 A is a preformed, custom-manufactured, conical, rotation-symmetric, slightly enlarged single root press-fit technology implant reflecting a major portion of the root. The retention elements are uniformly

distributed around the implant surface to provide a screw like mechanism when the implant is rotated in the alveolar bone.

Prior German Pat. No. DE 41 00636 A describes a root shaped implant produced by copy milling without any details on the design of the implant
5 surface.

German Pat. No. DE 195 13 881 describes a method enlarging the implant by doubling the width of the periodontal ligament. The whole bone contact section has a number of rectangular, equidistantly spaced, honeycomb-shaped cavities.

10 US Pat. No. US 4 187 608 concerns an exact replica of the extracted tooth, manufactured from porous metal or ceramic through a special sinter process for better adherence and ingrowths of bone matrix .

US Pat. No. US 2005/0048440 A describes an identical replica with special treatments e.g. etching, sandblast, hydroxyapatite coverage and/or drill holes
15 of the implant surface for improved bone adherence.

None of the above mentioned patents using root replicas were clinically sufficiently successful and for that reason all these methods are not established for routine clinical use. Due to the failures of these kinds of dental
20 implants till now rotation-symmetric implants are the state of technique, when immediate tooth replacement with a dental implant is provided.

DESCRIPTION OF THE INVENTION

25 The aim of the invention is the production of an individual non rotation-symmetric implant by copying the original tooth or an impression of the tooth

socket and modifying the implant surface with protruding macro retentions, causing only minimal trauma to the alveolar bone and providing a reproducible and shorter healing period.

For that reason macro retentions must be restricted to special regions to allow
5 for a non-traumatic osseointegration by strictly respecting the strongly variable quantity and/or quality of the surrounding alveolar bone next to the implant surface. It is important to know that the anatomy of the tooth socket consists of thin layers of cortical bone on the inner and outer side of the alveolar ridge and mainly spongy bone between the roots and around the tip
10 of the roots. Cortical bone covering the root is very thin with no or few blood vessel and prone to fracture and pressure induced resorption. In contrast, spongy bone has an excellent blood supply and can be compressed to a certain degree with local fractures causing minimal trauma only, containing a lot of bone morphogenic protein and cells, ensuring a favourable and short healing
15 period.

For that reason the invention describes an implant with protruding macro retention elements strictly restricted to surface areas next to spongy alveolar bone, which can be found regularly in the interdental space between the roots.

The upper and especially the lower jaw withstands stress of macro retentions
20 more easily in regions with spongy bone and in direction of the tooth row that is to say in the interdental space, corresponding to the longitudinal bending force resistance of the bone, especially of the lower jaw. Pressure applied in transverse direction towards the thin cortical bone of the alveolar ridge as induced by macro retentions in this sensitive area, or also generally enlarged
25 dental implant diameters for press-fit technology or inadvertent mechanical force during implant insertion, leads to bone fracture and/or pressure induced

unaesthetic resorption of the thin bone layer especially on the outer side of the upper and lower jaws and implant loss.

These macro retentions applied only next to spongy bone have increased and longer lasting primary stability while preventing bone fracture and pressure
5 induced bone resorption of the thin buccal bone layer causing implant failures. Conversely to the technical state of the art, the implant size and shape next to the thin cortical bone fits without any pressure by using the same implant size, or even better slightly reduced implant size, preventing even the slightest pressure to the thin cortical bone layer. Macro retentions
10 must not be added next to the thin cortical bone to avoid fracture and pressure induced bone resorption by all means.

In contrast to the state of technology the implant body is under no circumstances enlarged, neither equally nor unequally over the entire bone-implant surface to avoid bone resorption by pressure to the entire surface at
15 the same time point. This press fit technology with pressure distributed equally over the entire implant surface, leads to implant loss because of the regular conical form of natural roots combined with pressure induced bone resorption all over the implant surface at the same time.

According to the invention the geometry of the extracted tooth or extraction
20 socket respectively are taken by e.g. impressions, laser scanning, computer tomography, magnetic resonance imaging or other techniques and modified with macro retentions with the help of a computer program. Macro retentions are protrusions from the implant surface into the area of the extraction socket of at least 0.08 mm, preferably at least 0.4 mm. The ever essential primary
25 stability is maintained mainly by localized macro retentions, compressing only spongy bone, which are stabilising the implant during the early healing period, preventing that the implant gets lost. After implant insertion pressure

induced resorption takes place in the region of the macro retentions caused by remodelling of the adjacent bone. In parallel the bone can heal to the implant surface in all the regions where no macro retentions are preformed directly, without any prior pressure induced resorption always delaying
5 osseointegration. The splitting of different healing mechanisms and healing periods leads to the secondary stability called osseointegration without implant loss and/or unpleasant bone resorption.

The aim of the present invention is the production of a dental implant which is not only a exact replica of the root or extraction socket to get maximal
10 implant and bone contact but a dental implant that carries also special macro retentions strictly respecting the anatomy e.g. the bone quality and quantity and the different capabilities to withstand load bearing forces of macro retentions maintaining essential primary stability for osseointegration and preventing bone resorption and even fracture of the thin cortical bone layers.

15 Macro retentions are essential to keep the conical root analogue implant safely in place during the healing period at least for six to eight weeks by localized compression of exclusively the spongy bone to promote rapid and secure osseointegration on all areas with strain less fit, where no prior pressure induced resorption takes place. In all regions of pressure,
20 osseointegration is delayed, due to prior pressure induced bone resorption.

Contrary to the macro retentions, micro retentions cover the entire surface of the root replica adjacent to bone. Micro retentions are created by sandblast of the preferred implant material ZrO_2 (Y-TZP Tetragonal Zirkonia Polycrystal, Yttrium stabilized) and have a surface roughness of 40 μm to 70 μm . The
25 surface is therefore treated with pulsed particular blast e.g. Aluminiumoxid- or Zirconoxid particles blasts with 1 to 3 bar pressure in the size of approximately 250 μm between 0.1 to 0.5 seconds per blasted area, in the non

sintered material, creating an average roughness of 50 μm to 70 μm . The implant is subsequently sintered.

- The number of macro retentions depends on the anatomical circumstances e.g.
- 5 position of the root (upper-, lower jaw, front-, premolar-, or molar region, single-, or multi rooted, and length of the root). In single rooted teeth between 2 and 8, in most cases 4 macro retentions can be designed. The height of these retentions, that is to say the highest elevation above the root surface is minimally 0.08 mm or better 0.1 mm and preferably greater than 0.4 mm.
- 10 When applying macro retentions with different heights in one implant, the height can increase starting from the first macro retention next to the apex following the conical shape of the root towards the crown, in order to avoid any unnecessary damage to the tooth socket at the time point of insertion. No macro retentions are placed on the root next to the bony margin (implant
- 15 shoulder) in order to protect the thin interdental spongy bone preventing unaesthetic recession of the papilla. On the contrary, the implant diameter is preferably reduced by 0.05 mm to 1 mm, if necessary by 1.5 mm to avoid pressure induced resorption and fracture of the thin cortical bone layer, respectively, at any cost. In general, macro retentions can be larger in cases
- 20 with more spongy bone and/or if the spongy bone is less dense.

In an alternative embodiment of the invention with regard to single rooted teeth preferably longish macro retentions are created in longitudinal direction in the bony interdental root areas preferably next to the thicker palatal/lingual bony regions to serve as guidance. This will avoid

25 application of pressure to the thin cortical bone buccal, leading to pressure-induced bone resorption and even fracture and dislocation in buccal direction

of the single rooted implant during insertion. In multirooted teeth the anatomy averts the possibility of dislocation during insertion.

Another embodiment of the invention is shortening of the implant at the apex, preferably by 0.3 mm to 1 mm in order to avoid compression of the bone
5 around the apex of the implant, leading to pressure in extraction direction on the implant later on.

BRIEF DESCRIPTION OF THE DRAWINGS

- 10 FIG.1 axial cross section of the human upper jaw in the middle of the roots (according to an axial computed tomography scan)
- FIG.2 section of a tooth in the upper jaw in section II-II according to FIG.1
- FIG.3 section of a tooth in the upper jaw in section III-III according to
15 FIG.1
- FIG.4 a premolar - buccal view
- FIG.5 root-analogue implant in accordance with the invention with crown stump and macro retention – buccal view
- FIG.6 premolar of figure 4 – interdental view
- 20 FIG.7 implant according to FIG.5 with macro retentions in the interdental space – interdental view
- FIG.8 cylindrical titan-implant corresponding to the state of the technology
- FIG.9 some examples for the arrangement of macro retentions on the
25 implant
- FIG.10 a - h cross section schematic of various forms of macro retentions
- FIG.11 an embodiment of the invention with extended root and
- FIG.12 an embodiment of the invention with discrete macro retentions.

DESCRIPTION OF THE DRAWINGS

FIG.1 illustrates a human upper jaw, the outer side is referred to as buccal, the inner side as palatinal. 101 indicates a cylindrical implant corresponding to the state of the technology, leading to clearly visible gaps and incongruences marked as 102 causing bone resorption and a lack of primary stability.

The bone jaw is not uniform, but consists of compact bone marked with 104 and spongy bone marked as 103. The spongy bone is extended in the interdental space and around the lower parts of the roots, especially in the lower jaw. In contrast, the compact bone covers as a thin, non compressible and non load bearing, cortical layer the upper part of the root palatinal, lingual, extra thin buccal and labial.

FIG.2 illustrates a cross section along the line of intersection II-II of FIG.1 through a tooth in bucco - palatinal direction, clearly showing the very thin cortical bone layer covering the outer (buccal) face of the root.

FIG.3 shows a cross section in the row of teeth according to intersection line III-III of FIG.1. Spongy bone (103) extends in the interdental space. The invention describes macro retentions (107) in the area of spongy bone, preferably in the interdental space, where enough spongy bone is always present. In order to reach primary stability, selective macro retentions in spongy bone are sufficient. The areas kept free of macro retentions and preferably of implant diameter reduction according to the invention are marked in the figures as 110. 105 denotes the maxillary sinus.

FIG.4 shows the buccal view of a human tooth and FIG.5 a corresponding implant with a crown stump (106) and macro retentions (107) according to the invention. FIG.6 shows an interdental view of the same premolar. The

retraction (108) between the roots and the split of the root in two roots in the apical third (109) is illustrated in FIG.6.

FIG.7 illustrates a corresponding implant according to the invention. This view shows clearly macro retentions in the interdental space only. The areas kept free of macro retentions and preferably of implant diameter reduction according to the invention are marked in the figures as 110.

In comparison to the embodiment according to the invention FIG.8 shows an implant according to the state of the technology, which is rotation symmetric, with a screw like winding for macro retentions.

10 The form of macro retentions (107) can be multifaceted as shown in figures 10 a - h. The depicted profiles can also be used in mirror image except for 10 b and 10 g. In principal any kind of protrusion is eligible e.g. undulated, spikes, teeth, rectangular or rounded, triangular or reticular. These macro retentions can be of one piece with the implant or added onto the implant, in
15 this case preferably by cementing or gluing. Macro retentions can be continuous (107) or interrupted (FIG.9, 109). Interrupted macro retentions running in circumferential direction can be in line, shifted or randomly distributed (FIG.12, 113).

The herein described invention can be adapted by means of computer aided design and computer aided manufacturing with an already existing or slightly
20 modified software in a way that missing parts of the root (e.g. status post root resection) can be restored, so that the original space in the tooth socket is filled. By the same token tooth anomalies can be corrected and the root form adapted to facilitate implantation: super numerous and significantly curved
25 roots can be partially or completely omitted or straightened. Bifurcated roots with a small bony septum can be partially or completely fused (FIG.3, 111)

after resection of parts or the complete septum, preferably with an impression or computer aided measurement.

The connection of the implant to the crown can have various forms, as are known from the state of the technology, e.g. screw thread, inner- or outer cone, crown stump and glued or screwed connections. According to the state of technology the connection between the implant body and the crown can be in height, above or below the gingiva. Implantation in the level or below the gingival is preferable in cases of poor bone quality or in case of infection and allows for osseointegration without intense functional load. On the other hand, in cases with good bone quality the crown can be fixed to the implant immediately after implant insertion according to early implant loading protocols.

The implant can be manufactured from any material known from the state of technology, preferably ZrO_2 . It has to be biocompatible and non resorbable. The surface of the implant in the bone connection area has to be roughened according to the state of technology by sandblast, etching and/or coated with hydroxyapatite (roughness corresponds to micro retentions). Growth factors and/or stem cells can also be applied to the implant in order to enhance growth of bone and gingival respectively. While there has been described what is believed to be the preferred embodiment of the present invention, further modification of the surface of the implant or regarding crown technology may be made thereto without departing from the spirit of the invention.

An important aspect of the invention is the possibility to deepen the tooth socket in cases with periodontal lesions or short roots in order to lengthen the implant in longitudinal direction in the axis of the tooth. This leads to an increase of the surface and improved stability (FIG.11, 12). In these instances

the dental implant consists of a root replica and a cylindrical part (114) extending the apex of the implant corresponding to the drilled hole extending the natural tooth socket in the apex area.

Further macro retentions can be added to the extended part of the implant
5 (FIG. 11, 12) Macro retentions can be distributed around on the cylindrical extension part of the implant, as described above, according to the bone quality and quantity. The cross section of the root extension can also be oval or have any other form, because the implant is never screwed but tapped into place.

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Another aspect of the invention is the prevention of gingival and/or bony pockets in multi rooted teeth with parodontitis. In these cases the bifurcation or trifurcation can be extended towards the apical direction after resection of adequate septal bone (FIG. 3, 111).

15 Another possibility is the modification of the tooth socket depending on the bone quality and quantity prior to manufacturing of the implant and creating corresponding macro retentions on the implant body.

THE CLAIM

1. A tooth socket-analogue dental implant with macro retentions protruding from the implant surface into the alveolar bone (107, 113, 116), characterized that those macro retentions (107, 113, 116), are limited to surface areas of the implant next to spongy and thick bone.
2. A tooth socket-analogue dental implant with macro retentions protruding from the implant surface into the alveolar bone (107, 113, 116), characterized that those macro retentions (107, 113, 116), are limited to surface areas in the interdental space and in case of terminal teeth toward the bone at the end of the tooth row.
3. A dental implant as claimed in claim 1 and 2 characterized either following exactly the alveolar bone buccal, lingual/palatinal of the root area or being reduced.
4. A dental implant as claimed in any of claims 1 to 3 characterized with macro retentions (107) orientated in right angles to the longitudinal axis of the extracted tooth.
5. A dental implant as claimed in any of claims 1 to 4 with macro retentions (107) characterized for the profile of which any kind of protrusion is eligible e.g. undulated, rectangular, triangular, spikes, teeth, or reticular, in case with rounded edges.
6. A dental implant as claimed in any claim 1 to 5 with macro retentions (113, 116) characterized by consisting of numerous straight or waved protrusions with a small surface area.
7. A dental implant as defined in any of claims 1 to 6 in single rooted teeth characterized with at least one, preferably two macro retentions

in longitudinal axis of the tooth located in the interdental space next to the palatal/lingual portion of the bone.

8. A dental implant as defined in any of claims 1 to 7 characterized with macro retentions of a height, that is to say the highest elevation protruding over the implant surface into the alveolar bone surface, of minimally 0.08 mm, preferably 0.1 mm and especially preferably at least more than 0.2 mm.
9. A dental implant as defined in claims 1 or 2 characterized with a diameter reduction of the implant by standing back behind the alveolar bone in the root area of 0.05 to 1.0 mm, if applicable up to 1.5 mm buccal and/or palatal/lingual.
10. A process for the production of a dental implant as defined in any of claims 1 to 9, in which the - if applicable modified- tooth socket determines the shape of the implant, which is characterized by adding macro retentions onto the implant surface and if applicable reducing the diameter in the area of the root.
11. A process for the production of a dental implant as defined in any of claims 1 to 8, in which the - if applicable modified- tooth socket determines the shape of the implant, which is characterized by adding macro retentions onto the implant surface, preferably by gluing.
12. A process for the production of a dental implant as defined in claims 10 and/or 11, in which the implant is manufactured of ZrO_2 , which surface is treated with pulsed particular blast e.g. Aluminiumoxid- or Zirconoxid particles in the size of approximately 250 μm between 0.1 to 0.5 seconds per blasted area in the non sintered material with 1 to 3 bar pressure creating an average roughness of 50 μm to 70 μm . The implant is subsequently sintered.