REVIEW ARTICLE

Straumann dental implant: A complete review

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ABSTRACT

The aim of this paper is to review different types of Straumann dental implants and their effect on osseointegration. The major challenge for contemporary dental implantologists is to provide oral rehabilitation to patients with healthy bone conditions asking for rapid loading protocols or to patients with quantitatively or qualitatively compromised bone. These charging conditions require advances in implant surface design. The elucidation of bone healing physiology has driven investigators to engineer implant surfaces that closely mimic natural bone characteristics. This article provides a comprehensive overview of surface modifications of the Straumann dental implants that beneficially alter to enhance osseointegration in healthy as well as in compromised bone. This article discusses Straumann dental implants that have been successfully used for a years. The Straumann Dental Implant System offers a wide range of implant lines with diverse body and neck designs and different materials. This focuses on the Titanium and Roxolid Tissue Level and Bone Level implants with a parallel-walled endosteal design. These implants can be placed with the instruments from the Straumann Surgical Cassette while using very similar surgical procedures.

Key Words: Straumann, Dental Implants, Endosseous implant.

INTRODUCTION

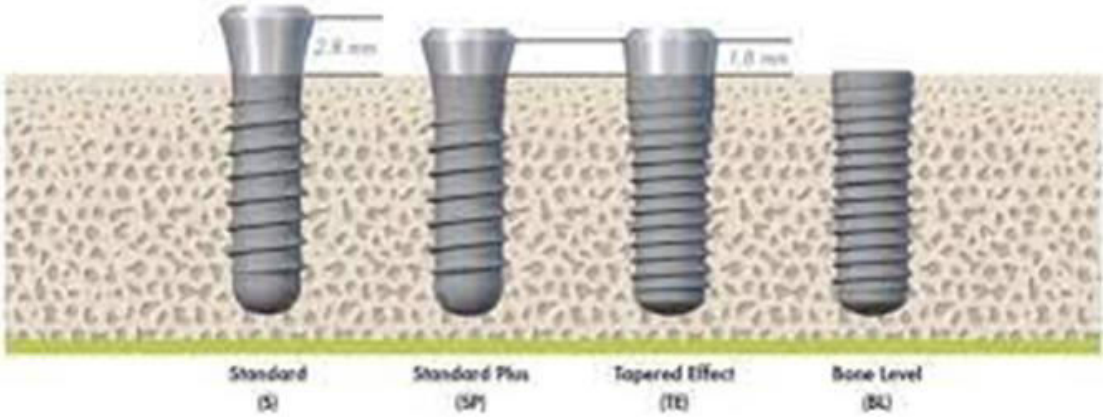
Nowadays, dental implants represent a reliable treatment option in oral rehabilitation of partially or fully edentulous patients in order to secure various kinds of prostheses. Dental

implants have become a standard procedure for single tooth replacement in the esthetic zone, providing many advantages but also challenges in sophisticated patients. Branemark et al. first described the process of osseointegration more than 45 years ago [1, 2]. Their work launched a new era of research on shapes and materials of dental implants. But it was not until the last decade that the focus of biomedical research shifted from implant geometry to the osteoinductive potential of implant surfaces. Today, roughly 1300 different implant systems exist varying in shape, dimension, bulk and surface material, thread design, implant-abutment connection, surface topography, surface chemistry, wettability, and surface modification[3]. The common implant shapes are cylindrical or tapered[4]. Surface characteristics like topography, wettability, and coatings contribute to the biological processes during osseointegrationby mediating the direct interaction to host osteoblasts in bone formation[5]. In general, the long-term survival rates of dental implants are excellent. However, implant failures still occur in a small quantity of patients. Primary implant failure due to insufficient osseointegration occurs in 1-2% of patients within the first few months[6]. Secondary implant failure develops several years after successful osseointegration in about 5% of patients and is commonly caused by peri-implantitis[6,7]. The demographic trend in industrialized countries consecutively leads to an increase of elderly patients with advanced clinical conditions like impaired bone quality or quantity or other challenging comorbidities. Osseointegration might be impaired in patients with diabetes mellitus, osteoporosis, and comedication with bisphosphonates or following radiotherapy[8]. These patients remain a great challenge in dental implantology and prompt the need for bioactive surface modifications that accelerate osseointegration after implant insertion[9]. Besides, the aim of designing new bioactive surface properties is to accelerate osseointegration for more convenient, early loading protocols[10]. The primary goal of biomedical research on surface modifications is to facilitate early osseointegration and to ensure a long-term bone-to implant contact without substantial marginal bone loss.

STRAUMANN IMPLANTS

There are various types of Straumann implant available (Fig 1)

Fig 1: Straumann Implants according to Bone level



1. **Standard Implant –** The classic Tissue Level Implant Straumann Standard Implants have a smooth neck section of 2.8mm and are especially suitable for classic single-stage procedures, where the implant is placed at soft tissue level and not covered with soft tissue during the healing phase. The Standard Implant uses the Straumann synOcta connection together with its corresponding prosthetic components, the Straumann synOcta portfolio and the Straumann Solid Abutment. The thread pitch on the Standard Implants measures 1mm for the ∅ 3.3mm implants, and 1.25mm for all other diameters[11].

2. **Straumann Standard Plus Implant –** The implant for flexible placement Straumann Standard Plus Implants have a shorter smooth neck section of 1.8mm and that allows flexible coronoapical implant placement in combination with transor subgingival healing. This offers the dental surgeon additional options that are particularly useful in the anterior tooth region of the maxilla, where esthetic demands are high. Similar to Straumann Standard Implants, this implant type uses the Straumann synOcta connection together with its corresponding prosthetic components, the Straumann synOcta portfolio and the Straumann Solid Abutment. The thread pitch on the Standard Plus Implants measures 1 mm for the ∅ 3.3mm implants, and 1.25mm for all other diameters[11].
3. **Straumann Standard Plus Narrow Neck CrossFit Implant**- The Narrow Neck CrossFit (NNC) Implant is a 3.3mm diameter implant with a narrow prosthetic platform. Its internal connection provides expanded prosthetic options and solutions for treatment in the upper and lower jaw, wherever space is limited. The NNC Implant is a Standard Plus (SP) Tissue Level Implant with a machined neck of 1.8mm in height. With the introduction of Roxolid material, it was possible to incorporate an internal CrossFit connection and, at the same time, offer a strong small-diameter implant – resulting in added confidence for the operator. The implant body and thread design is the same as the Straumann 3.3mm Bone Level NC Implant. Narrow Neck CrossFit Implants use the Narrow Neck CrossFit (NNC) prosthetic components[11].
4. **Straumann Standard Plus 4mm Implant-** The Straumann Standard Plus 4mm Implant is Straumann's shortest implant. The implant features a Standard Plus design for easy oral hygiene in the posterior regions, synOcta internal connection compatibility with the existing Tissue Level prosthetic portfolio, and a Bone Level thread to increase the implant-tobone contact. The most advanced Straumann technology combined within a very short implant[12].
5. **Straumann Bone Level Implant** – Straumann expertise applied at bone level implants are suitable for bone level treatments in combination with trans- or subgingival healing. The implant's rough surface extends to the top of the implant and the connection is shifted inwards. The Bone Level Implant uses a conical-cylindrical connection, the CrossFit connection, together with its corresponding prosthetic CrossFit components from the Bone Level product portfolio. A cylindrical outer contour and a thread pitch of 0.8mm that tapers off in the coronal part of the implant provide excellent primary stability[11].

IMPLANT-ABUTMENT CONNECTIONS

1. Straumann synOcta Morse taper connection, the Straumann synOcta concept was introduced worldwide in 1999, using the well-known Morse taper design principle developed in 1986. The mechanically locking friction fit of the Straumann synOcta internal connection, with an 8° cone and an octagon for the repositioning of prosthetic parts, shows improved performance over traditional external connections. Abutment loosening, even in screw-retained situations, has virtually been eliminated. The Straumann synOcta connection is available for all Straumann Standard and Standard Plus, Implants with the Regular Neck (RN) and Wide Neck (WN) platform[12].
2. Straumann Narrow Neck CrossFit connection Implant is a 3.3mm diameter implant with a narrow prosthetic platform. The NNC Implant is a Standard Plus (SP) Tissue Level Implant with a machined neck of 1.8mm in height. The implant body and thread design is the same as the Straumann 3.3mm Bone Level NC Implant[12].
3. Straumann Bone Level CrossFit connection applies the know-how and benefits from the Straumann synOcta Morse taper connection to the connection requirements at bone level. Similar to the Straumann synOcta connection, the mechanically locking friction fit of the 15° conical-cylindrical CrossFit connection with four internal grooves has excellent long-

term stability under all loading conditions and virtually eliminates screw loosening. The CrossFit connection is available for Straumann Bone Level Implants only. Straumann Bone Level Ø 4.1mm and Ø 4.8mm Implants have the same connection, the Regular CrossFit connection (RC), and share the same secondary components. Straumann® Bone Level Ø 3.3mm Implants feature the narrow CrossFit connection (NC). The corresponding secondary components are color-coded: yellow = NC connection and magenta = RC connection[13].

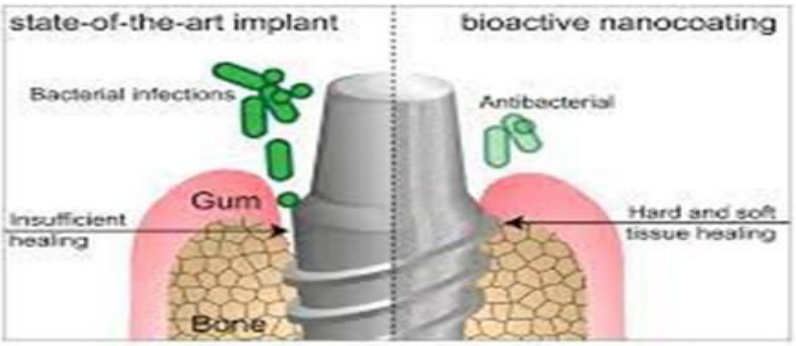
MATERIAL

Roxolid is a first groundbreaking material (Fig 2) having unique SLActive surface specifically designed for use in dental implantology.

Fig 2: Roxolid Implant

The titanium-zirconium alloy is stronger than pure titanium[1,2] and has excellent osseointegration properties[3-5]. This combination of properties is unique in the market, since no other metallic alloy unifies high mechanical strength and osteoconductivity. Roxolid Implants offer more treatment options than conventional titanium implants[14]. Since it is made up of zirconia alloy, large grit-blasting generates the macrolevel aspects of the surface while the microtopographic features are induced by acid etching with HCl/H_2SO_4. Chemical modification to a sandblasted, large-grit, acid-etched (SLA) implant surface. Chemical composition of the SLA structure was found to be titanium oxide (TiO_2). Liquid composition helps to immobilize proteins, enzymes or peptides on biomaterials for the purpose of inducing specific cell and tissue responses. One aaproach uses cell-adhesion molecules like fibronectin, vitronectin, Type 1 collagen, osteogenin and bone sialoprotein. Second approach uses biomolecules with osteotropic effects which range from mitogenicity (interleukin growth factor-1, FGF-2, platelet derived growth factor-BB) to the increasing activity of the bone cells (Fig.3), which enhances the collagen synthesis for osteoinduction.

Fig 3: Antibacterial property of Liquid composition



Main features are hydrophilicity, Protein adsorption activity within the first weeks, enhanced angiogenesis and bone healing within the first few days after contact with the new surface.

This surface reduced the average healing time from 12 weeks (TPS Surface) to only 3-6 weeks.

SLActive implants are made of highly pure titanium and are specially treated to give them an optimal surface topography for bone cells to attach themselves. Using an innovative manufacturing process, the surface is conditioned in nitrogen and immediately preserved in an isotonic saline solution. This maintain its high surface activity, which would otherwise be lost due to reaction with the atmosphere. On the basis of preclinical and clinical results, these properties accelerates the healing process of osseointegration with the result that early bone to implant contact is significantly increased. This in turn results in greater implant stability and reduces the risk of implant failure by 60%.

SURFACE

SLActive significantly accelerates the osseointegration process and delivers a successful and patient-friendly implant treatment. According to Allum et al[15] High success and survival rates in compromised patients: diabetic, smokers, irradiated patients. SLActive reduces initial healing time to 3–4 weeks*10-14. Increased treatment predictability in critical protocols[6-15]. According to Ettinger et al[16] most implant failures occur in the critical early period between weeks 2 and 4. Although similar healing patterns were observed for both SLA and SLActive. Implants, bone-to-implant contact (BIC) was greater after 2 weeks and significantly greater after 4 week for SLActive® (p-value<0.05)[16].

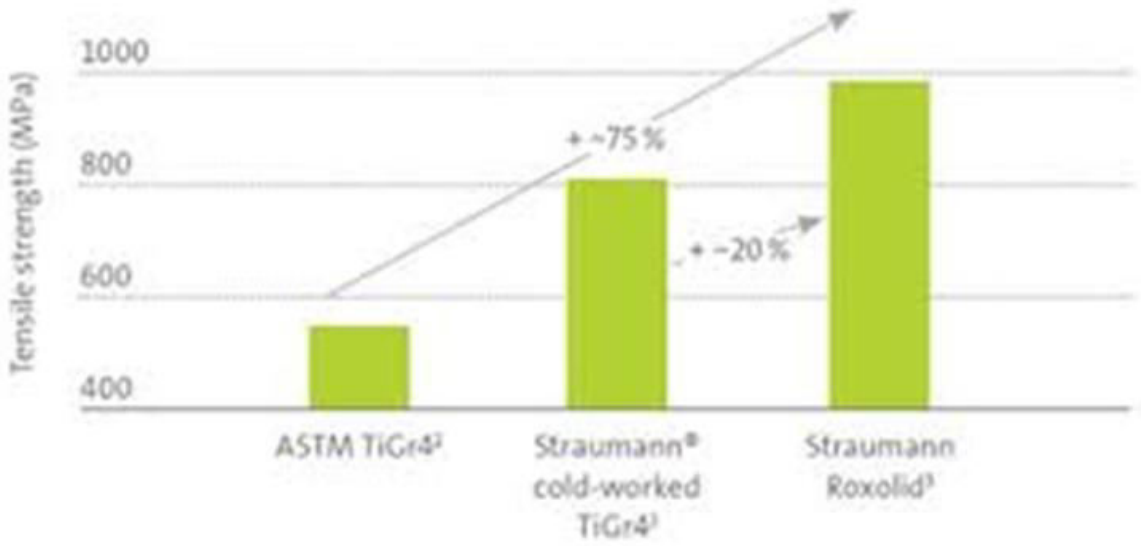
TRANSFER PIECE

The Bone Level Tapered Implants are delivered with the Loxim Transfer Piece, which is connected to the implant with a snap-in mounting[17].

IMPLANT TYPES AND BONE DIMENSIONS

Straumann implants are available in the materials Roxolid® with the SLActive or SLA surface or titanium with an SLA surface. Roxolid implant is a metal alloy composed of approximately 15% zirconium and 85% titanium. Titanium-Zirconium alloys are stronger than pure titanium and have excellent osseointegration and biocompatibility properties (Graph 1).

Graph 1: Tensile Strength of Roxolid Straumann implant



IMPLANT POSITION

The implant is the focal point of the dental restoration. It provides the basis for planning the surgical procedure. To establish the topographical situation, the axial orientation, and the choice of implants, recommend the following: Make a wax-up/set-up on the previously prepared study cast. Define the type of superstructure. The wax-up/set-up can later be used as the basis for a custom-made X-ray or drill template and for a temporary restoration[18].

The implant diameter, implant type, position and number of implants should be selected individually, taking the anatomy and spatial circumstances (e.g. malpositioned or inclined teeth) into account. The measurements given here should be regarded as minimum guidelines. Only when the minimum distances are observed is it possible to design the restoration so that the necessary oral hygiene measures can be carried out. The final hard and soft tissue response is influenced by the position between the implant and the proposed restoration. Therefore, it should be based on the position of the implant-abutment connection. The implant position can be viewed in three dimensions: Mesiodistal, Orofacial and Coronoapical.

MESIODISTAL IMPLANT POSITION

The mesiodistal bone availability is an important factor for choosing the implant type and diameter as well as the interimplant distances in the case of multiple implants. The point of reference on the implant for measuring mesiodistal distances is always the shoulder, being the most voluminous part of the implant. All distances are rounded to 0.5mm. The following basic rules are recommended i.e the minimal distance to adjacent tooth should be 1.5mm from the implant shoulder to the adjacent tooth at bone level (mesial and distal) is recommended. For single-tooth restoration, the implant is placed centered within the single-tooth gap. Straumann Standard and Standard Plus Implants for Straumann Tissue Level Implants, the gap size has to be considered for the selection of the shoulder diameter (NNC, RN, WN). The measurement is made at bone level from the adjacent tooth to the center of the implant and between implant centers. The minimal distance of 3mm between two adjacent implant shoulders is important to facilitate flap adaptation, avoid proximity of secondary components and provide adequate space for maintenance and home-care[19].

OROFACIAL IMPLANT POSITION

According to Robert et al [20] the facial and palatal bone must be at least 1mm thick in order to ensure stable hard and soft tissue conditions. The restoration-driven orofacial implant position and axis should be chosen such that screw-retained restorations are possible.

CORONOAPICAL IMPLANT POSITION

Straumann dental implants allow for flexible coronoapical implant positioning, depending on individual anatomy, implant site, the type of restoration planned, and preference. In the anterior area, a deeper coronoapical implant position is better for esthetic reasons. In this situation, the use of Roxolid Straumann Standard Plus or Bone Level Implants is recommended. Ideally, in the esthetic region, the implant shoulder should be positioned about 1mm apical to the cemento-enamel junction (CEJ) of the contralateral tooth or 2mm subgingival of the prospective gingival margin. Straumann Bone Level Implants are best set with the outer rim of the narrow 45° sloping edge (chamfer) at bone level. Ideally, in the esthetic region, the implant shoulder should be positioned about 3–4mm subgingival of the prospective gingival margin and with the correct implant orientation.By using the Diagnostic T in the patient's mouth or on the cast, an initial impression of the spatial relations for the choice of the implant shoulder diameter and prosthetic reconstruction can be obtained. The

vertical bone availability determines the maximal allowable length of the implant that can be placed.

CONCLUSION

Therefore, the strength of roxolid implants is reflected in daily practice since it has a low fracture rate of 0.04 %. This is the cumulated fracture rate of all Roxolid small-diameter Implants in the market and is significantly lower compared to our titanium implants. Titanium-zirconium alloys are stronger than pure titanium and have excellent osseointegration and biocompatibility properties.

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