

# THE IMPORTANCE OF IMPLANT- ABUTMENT CONNECTIONS

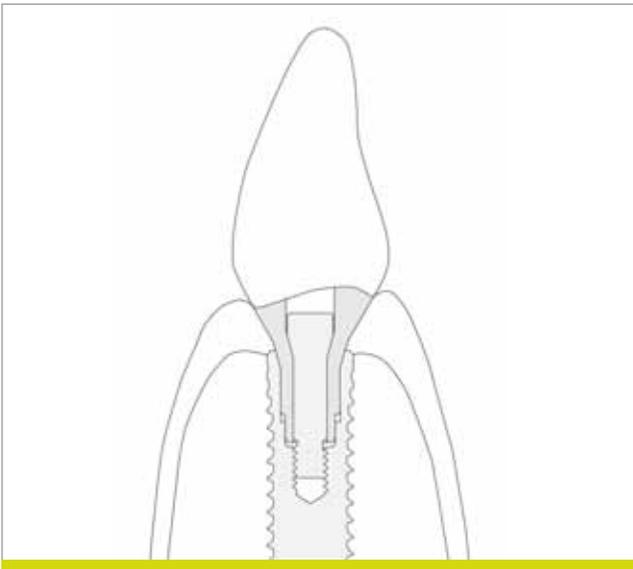


## The importance of implant-abutment connections for the success of implant-borne restorations

In this document we stress the importance of high-quality prosthetic components and of the abutment-implant connection, in particular. An underlying prerequisite is the professional work of the restorative team. High-quality products facilitate the work of the surgeon and the dental technician and make the treatment outcome more predictable. However, the skill of the surgeon in placing the implant and the experience and ability of the dental technician in designing the prosthetic restoration are without doubt the most relevant factors for the successful outcome of the treatment.

Successful implant therapy is not only a result of a well-osseointegrated implant with beneficial effects on the bone and soft tissue. A large degree of success, especially in terms of esthetics, quality of life and patient satisfaction, depends on the prosthetic elements<sup>1</sup>. In particular, the connection between the implant and the abutment may be of great importance when it comes to long-term stability and the successful outcome of a restoration<sup>2,3</sup>.

This document illustrates properties of an implant-abutment connection in terms of handling, stability, strength, biological aspects, clinical aspects and success of a restoration. The right balance of connection design, materials used, precise state-of-the-art manufacturing, rigorous quality controls as well as many years of experience from Straumann provides prosthetic components with reliability and gives confidence to the patient and the restorative dentist.



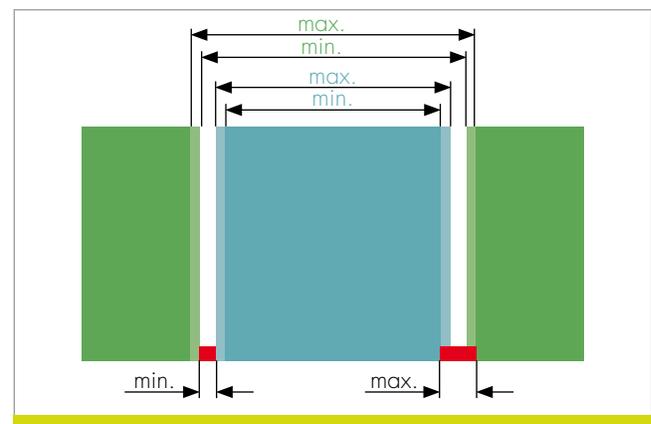
### Materials and characteristics

The materials used in prosthetic components play an important role. The use of state-of-the-art materials for abutment, screw and implant result in adequate ultimate and fatigue strength properties of the prosthetic component. Therefore, the right selection of materials for parts with optimal material properties is essential.

Another essential aspect is the use of high-quality materials. Straumann has a very high standard quality system and therefore performs thorough inspections of raw materials before they undergo the manufacturing process. This ensures that only high-quality materials are used according to internal requirements that are higher than applicable norms and standards.

### Tolerances

In addition to the design, the tolerances of the abutment, screw and implant also play a major role in an implant-abutment connection. Tolerance means the permissible limit or limits of variation in a physical dimension deviating from a nominal dimension. Dimensional tolerances, for instance, define the possible space between two connecting components (e.g. outer diameter of an abutment and inner diameter of an implant as shown in the picture below). Geometric tolerances define the shape of a feature to be within a certain tolerance.



Smart tolerances on the design as well as high-precision manufacturing are essential for the engagement and the functionality of the parts. The accurate fit of abutment, screw and implant is achieved by harmonizing and matching tolerances for the performance of the parts.

It is necessary to specify appropriate tolerances to maintain proper functionality. Straumann® abutments and screws on Straumann® implants are designed to function together as intended over time by following a controlled production and inspection process.

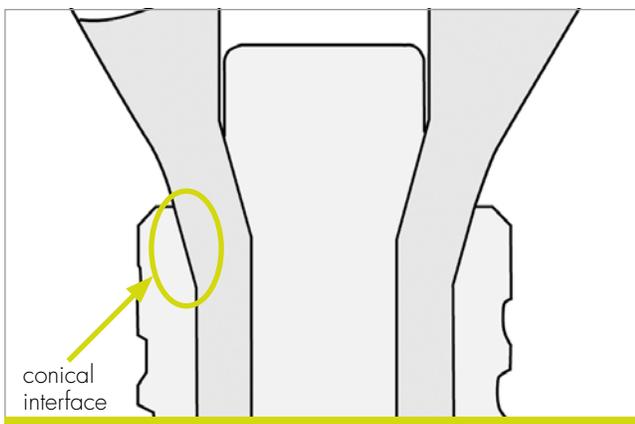
Harmonized and matched tolerances minimize the possibility of displacements of abutments in implants with and without applied forces, resulting in a connection with minimal wear and stability. Tolerances which are not aligned on an implant-abutment connection in its intended use may negatively impact on the stability and durability of the restoration. Therefore Straumann recommends to only use original Straumann components for all engaging parts as competitors do not know Straumann's tolerances. Combining Straumann products with parts from different manufacturers voids the Straumann® warranty.

## Design

### Connection design

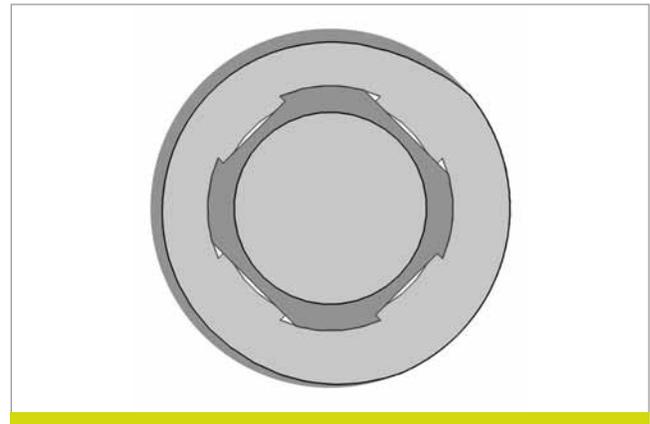
The shape of the load bearing surface is of great importance<sup>4,5,6,7</sup>. It is designed to allow for the connection to be sealed tight<sup>15</sup> and reduce sensitivity to lateral forces. A conical shape provides excellent load distribution of abutments onto implants<sup>6,7</sup>, good sealing properties, a defined seating position of the abutment and is designed to avoid micro-gaps<sup>15</sup>.

The conical shape of the connection allows for even stress distribution and prevents the occurrence of peak stresses within the implant, abutment and respective screw<sup>6,7</sup>.



Not only the shape of the load bearing surface, also the engagement of the part within the implant plays a significant role<sup>3</sup>.

In the Straumann® Bone Level implants, for instance, the CrossFit® connection (picture below) was designed to provide guidance during assembly and distribute loading forces to the implant.



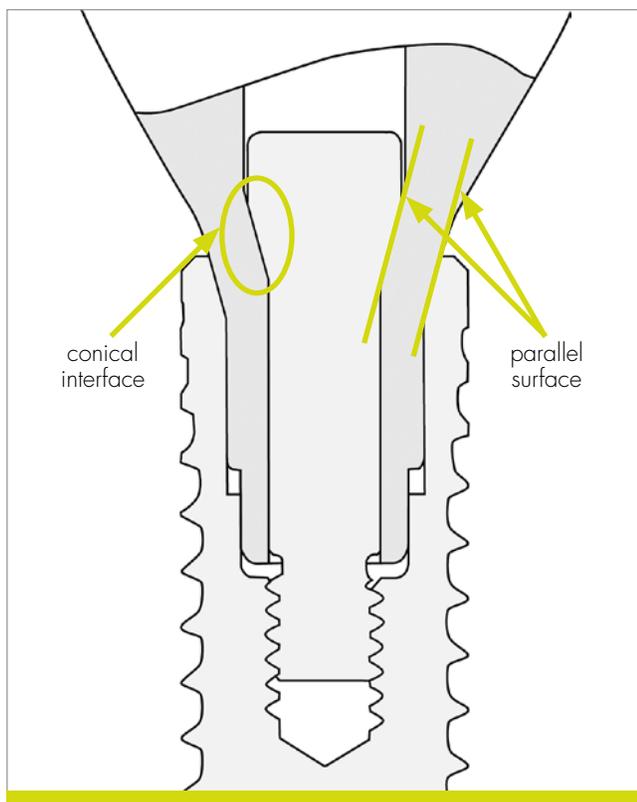
In the Straumann® Soft Tissue Level implants, the synOcta® Abutment was designed to provide guidance during assembly and to absorb loading forces to minimize movement of the coping.

Design harmony between the engaging parts is highly relevant. A restoration is only as strong as its weakest link; therefore, it is very important to design features and dimensions in terms of the restoration as a whole and not just looking at one component, e.g. only the implant or only the abutment. Harmonized designs between abutment, screw and implant strive to achieve optimal strength and load distribution throughout the entire construct<sup>6,7</sup>, providing a strong and reliable connection engineered for great stability and durability. Components manufactured for precise fit and ideal load distribution help to ensure maintenance of crestal bone and long-lasting esthetics<sup>2</sup>. Therefore, Straumann recommends using only original Straumann components for all engaging parts as competitors do not know Straumann's dimensions and features.

### Basal/occlusal screw design

The design of the screw plays an essential role in the stability and long-term reliability of a connection<sup>9</sup>. A design with a conical section on the screw head and the abutment increases the surface area to keep the screw from rotating and thereby minimizes the possibility of screw loosening<sup>9,10</sup>. In addition, a parallelism of the cone on the screw and the cone on the connection (only with titanium abutments) between implant and abutment is engineered to ensure optimal clamping force between the engaging parts.

The screw is also required to bear axial loads that occur through the tightening process thus a balance between design features and dimensions is important to prevent screw loosening and screw breakage.



### Surface quality

Smooth surfaces on components in contact seal the engaging surfaces and reduce wear<sup>11</sup>. This results in a connection with minimized wear and thus good stability. A smooth surface can also reduce or minimize the occurrence of wear debris<sup>11</sup>.

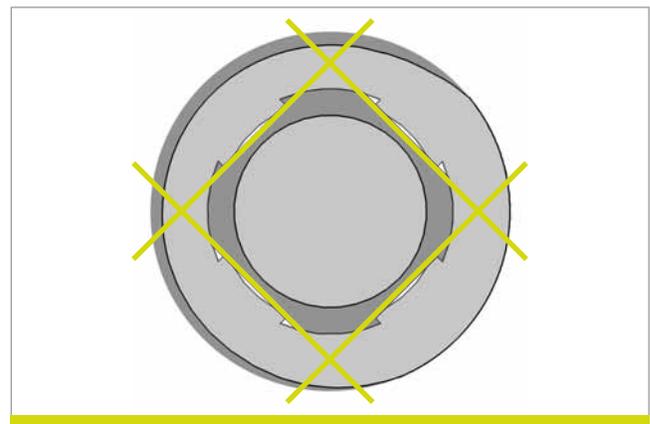
### Handling

#### Assembly

Handling characteristics are important, both for the restorative dentist (in terms of assembly of the prosthetic components on the implant) as well as for the dental technician (in terms of assembly of the restoration on the master model). During the assembly process, good guidance and tactile feedback (of when the assembly process is complete) is important. The result is a hassle-free assembly procedure which helps to save time, compensates for low visibility and does not require X-rays to confirm proper seating of the prosthetic components. This is a key requirement for the restorative dentist as visibility in the patient's mouth can be limited.

#### Geometry

One aspect of the design is the geometry of the connection. Connecting surfaces (highlighted in green in picture below) do not allow the abutment to rotate within the implant and can therefore only be assembled in its correct orientation. This feature provides precise orientation, precise repeated abutment placement and a stable connection of the prosthesis to the implant.

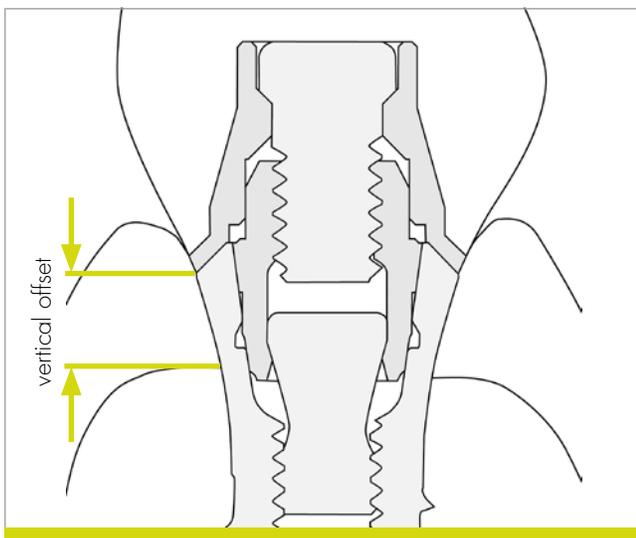


## Biological aspects

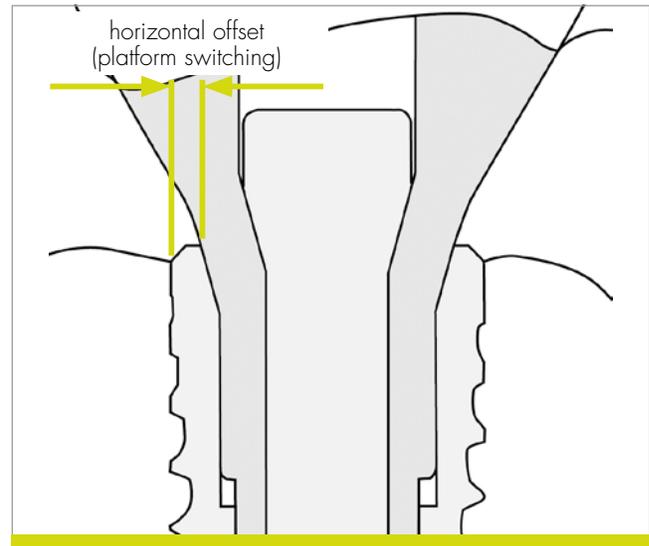
Individual oral hygiene of the patient is a relevant biological aspect that can influence the successful outcome of restorations<sup>6</sup>. The way the implant-abutment interface influences bone growth and surrounding soft tissue growth is an important success factor for restorations<sup>14</sup>. A gap between abutment and implant, caused for example by dimensions and tolerances that are not harmonized and matched, may be the cause for bacterial infiltration and accumulation and may subsequently impact on treatment success<sup>12</sup>.

## Biological width

A smart design of the connection as described in an earlier section of this document reduces bacterial infiltration into micro-gaps, the origin of bacterial contamination<sup>8</sup>. In this regard, consideration of the biological width – the distance from the bone crest to the micro-gap (point on surface at implant-abutment connection) – plays a crucial role when designing abutments and implants<sup>8</sup>. The biological width should be as big as possible<sup>12,13</sup> and therefore the connection should be moved as far away from the bone as possible. This can be achieved with an implant design emerging at the level of soft tissue (vertical offset) or with an implant design emerging at the level of the bone crest with so-called platform switching (horizontal offset through internal connection).



Implant emerging at the level of soft tissue



Implant emerging at the level of bone crest

A design according to these requirements avoids the infiltration of bacteria, which is important as it avoids bacterial contamination and related inflammation and bone loss<sup>14,15</sup>.

Straumann designs abutments and implants with specific tolerances on the conical section (load bearing and sealing surfaces between abutment and implant) to ensure that the connection is sealed tight to avoid the creation of a micro-gap<sup>15</sup>.

## Material biocompatibility

Biocompatibility of the material and compatibility with other materials are also crucial. Bioincompatibility of restorative parts can have an affect on adverse tissue reactions and inflammation of bone and soft tissue in patients.

Material compatibility is important for components in contact with each other, such as the abutment, screw and implant. Engaging parts made of different materials may trigger galvanic corrosion<sup>17</sup>, a process that can be triggered when two or more different sorts of metal come into contact in the presence of an electrolyte (e.g. saliva). The resulting corrosion products from the surfaces of the metals involved may contaminate the surrounding bone and soft tissue and leak into the mouth of the patient<sup>17</sup>. Straumann® only uses materials where biocompatibility was assessed.

## Clinical aspects of the implant-abutment connection

### Clinical experience

The best possible long-term reliability of implant-based restorations can be proven through clinical data. Clinical evidence provides tremendous confidence for the patient as well as the restorative dentist and confirms that the design, tolerances and materials of Straumann products contribute to the best possible long-term care for the patient.

### Summary

This document illustrates properties of an implant-abutment connection in terms of handling, stability, strength, biological aspects, clinical aspects and success of a restoration. The right balance of connection design, materials used, precise state-of-the-art manufacturing, rigorous quality controls as well as many years of experience from Straumann provides prosthetic components with reliability and gives confidence to the patient and the restorative dentist.

The combination of Straumann® abutments on Straumann® implants is designed to achieve the best possible performance of the implant-abutment connection and therefore of the entire restoration<sup>2,3</sup>. Straumann® abutments with screws and Straumann® implants are designed for each other to ensure harmony between design (shapes and features), tolerances, surface qualities and materials used.

Straumann® implant-abutment connections are designed to:

- ensure optimal load distribution to reduce peak stresses<sup>6,7</sup>;
- minimize the infiltration of bacteria and contamination in micro-gaps<sup>1,5</sup>;
- have a design harmony between abutment, screw and implant to provide optimal mechanical performance and long-term stability of a restoration<sup>2</sup>;
- ensure good handling of abutments and screws during the assembly process; e.g. with genuine Straumann® parts, the user receives tactile feedback when an abutment is placed correctly and when a screw is tight.

Straumann® delivers products built on innovation, precision, reliability and simplicity.

Straumann® parts have undergone mechanical testing and Straumann® parts have been engineered precisely to function in a particular mechanical configuration.

Combining parts from different manufacturers voids the Straumann® warranty. In the event of complications due to combining parts from different manufacturers, Straumann® disclaims all responsibilities.

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