Determining the Biological Sealing Quality of the Implant-abutment Interface Using *Streptococcus mutans* in Both, Conical and Internal Hex Connections

A comparative study

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Implants have been around for many years already, having a lot of advantages and high success rates, by some authors even higher than 90%. Nevertheless, throughout the years, problems and failures have occurred in practice which led to bone loss around the implants and even, in some cases, to losing the implant itself. The phenomenon behind this pathological process -peri-implantitis - is believed to be the microleakage which occurs at the implant-abutment interface.This happens due to the existence of a gap present between the implant and the prosthetic abutment. Moreover, the microleakage is amplified because of the, so called, pumo effect. The pump effect occurs when the crown-abutment complex is subjected to occlusal, vertical and oblique, forces. During these micro-movements of the abutment, the microleakage intensifies and the bacteria can easily enter inside the implant, where is impossible to reach and remove through oral hygiene, thus, creating the perfect conditions for peri-implantitis. There are two major types of implant-abutment connections widely used nowadays -internal hex and conical -which are believed to influence the phenomenon and, so, the outcome. In the present study, both types of connections are tested, using Streptococcus Mutans, a common bacteria found in the oral cavity.

Keywords: Implants, Peri-implantitis, Microleakage, Streptococcus mutans, Biocompatibility

Implantology is a very successful and reliable treatment that has come a long way in the past 10 years. Many difficult cases that were unfitted to treat with fixed prosthesis benefit, nowadays, of implant-retained fixed dentures[1,2]. Moreover, adjacent teeth of single edentation spaces, are no longer prepared for the conventional bridges, making the implant treatment much more conservative.

From the surgical perspective, many things have changed to make the protocol as safer and as predictable as possible, from the design of the surgical implant kits, to the latest trends of guided surgery [3]. All these factors have contributed to a simplified protocol that leave little room for human error. This translated, clinically, to a higher accuracy of implant placement and, implicitly, a higher rate of osseointegration [4].

So, while the surgical stage has somehow improved drastically, the failures tend to come from the prosthetic perspective. More exactly, because of the imperfect implant-abutment interface. It's this interface that allows micro-movements between the implant and abutment, movements which create some sort of pump effect, dragging oral bacteria inside of the implant. This phenomenon has been demonstrated in literature by many authors, including in vivo and in vitro study [5-7].

Clinically, this will translate to local inflammation of the surrounding soft tissues – peri-mucositis. If nothing is done to stop the vicious circle-pump effect + bacterial colonization of the implant + tissue inflammatory respons - bone resorption will follow, starting the stage of peri-implantitis [8,9].

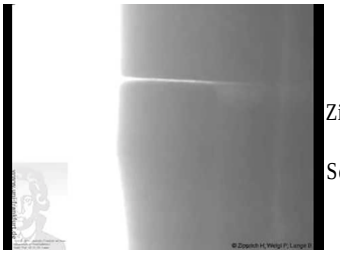

Fig. 1. The micromovement of the abutment (Copyright from Dipl.-Ing. Holger ZipprichPoliklinikfürzahnärztliche Prothetik, SektionWerkstoffkunde Theodor-Stern-Kai 7 / Haus 29, D-60590 Frankfurt am Main)

Experimental part

Matherials and methods

For this experiment, two different connection types were chosen – the standard internal hex connection and the conical connection. Two implants, together with their own abutments, of each type were selected.

The first step of the experiment was to inoculate all the implants with the chosen bacteria - *Streptococcus mutans.* To obtain the primary culture, *Streptococcus mutans* ATCC® 35668 ™(Microbiologics®) reference strain was cultured on Columbia agar supplemented with 5% blood (Sanimed, Romania) and incubated for 24 h in microaerophilic conditions (Genbagmicroaer, BioMerieux, France). From the fresh culture, a suspension was made in physiological saline with a final density of 0.5 McFarland, corresponding to a bacterial concentration of 108 germs/mL. From this suspension, about 1 µL was taken and inoculated into the dental implants.

The implants were then introduced into 2 mL of nutrient broth (Sanimed, Romania) and incubated in micro-aerophilic conditions at 37°C for 48 h. The tubes were also

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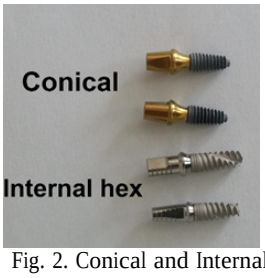

Fig. 2. Conical and Internal Hex connection systems implants

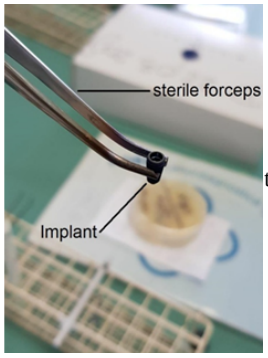

Fig. 3. The inoculation of the SM solution inside of the dental implant

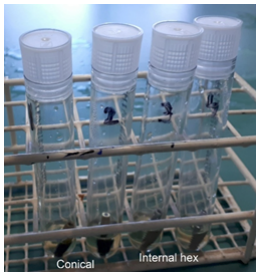

Fig. 4. The samples

Fig. 5. Sanyo incubator

numbered to be able to distinguish between the two connection types later on.

Results and discussions

The presence of bacteria in the tubes containing the dental implants with an internal hex connection was suggested by the macroscopic appearance of the broth, which became cloudy; while in the other 2 tubes, containing the implants with the conical connection, the broth remained clear.

For confirmation, the broth of all 4 tubes was cultured on Columbia agar supplemented with 5% blood, incubated in microaerophilic conditions at 37°C. Cultures examination was performed after 24 h, bacterial growth being present only in case of the samples containing the internal hex type of implants.

Compared to other studies in literature, the results are somehow similar, showing a better fit and sealing capacity of the conic implant-abutment interface [10,11].

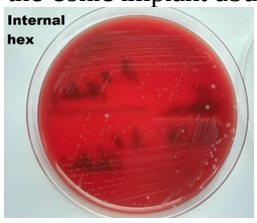

Fig. 6. Bacterial growth present on the internal connection probe

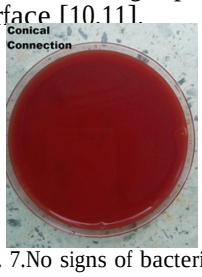

Fig. 7.No signs of bacterial growth present on the conical connection probe

However, in a similar study, Joao Paulo da Silva-Neto [10], inoculated the inner part of the implants with a bacterial suspension before tightening the abutments according to the manufacturer's recommendations. Afterwards, the implant-abutment complexes were immersed in sterile solution and left there for a number of days, between 7 and 14, at 35-37°C. After this period the solution was examined to see if there was any bacterial contamination from inside of the implant. The results were rather surprising as all types of connections were affected by microleakage, including morse taper ones. If in the first few days the morse tapper systems seemed to have better results, after a 14 days period there were no significant difference between the groups.

So, it's very hard to say if the morse-tapered implants, indeed, have no microleakage, but it's certain that they provide a way more stable conection, mechanically and biochemically.

Conclussions

The conical connection is, according to most authors, the best and the most reliable connection available. Both the present study and the literature review have pointed out a higher stability, lower micro-movements and lower to no microleakage.

Analysing it, from a clinical perspective, it is safe to assume that, due to all these characteristics combined, the morse tapered connection can lead to an improved outcome.

The lack of microleakage translates into much less chances for the oral bacteria to colonize the hidden spaces inside the implant, or at the implant-abutment interface. With other words, the chances of peri-implantitis and peri-mucositis are mch lower.

Even though all in vitro studies point out its advantages, only time will tell if the conical connection is, indeed, superior to the internal hex one, clinically.

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