Correlation between microleakage and screw loosening at implant-abutment connection

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PURPOSE. This study aimed to evaluate the correlation between microleakage and screw loosening at different types of implant-abutment connections and/or geometries measuring the torque values before and after the leakage tests. **MATERIALS AND METHODS.** Three different abutment types (Intenal hex titanium, internal hex zirconium, morse tapered titaniuım) with different geometries were connected to its own implant fixture. All the abutments were tightened with a standard torque value then the composition was connected to the modified fluid filtration system. After the measurements of leakage removal torque values were re-measured. Kruskal-wallis test was performed for non-parametric and one-way ANOVA was performed for parametric data. The correlation was evaluated using Spearman Correlation Test (α=0.05). **RESULTS.** Significantly higher microleakage was found at the connection of implant-internal hex zirconium abutment. Observed mean torque value loss was also significantly higher than other connection geometries. Spearman tests revealed a significant correlation between microleakage and screw loosening. **CONCLUSION.** Microleakage may provoke screw loosening. Removing torque values rationally decrease with the increase of microleakage. ***[J Adv Prosthodont 2014;6:35-8]***

KEY WORDS: Microleakage; Implant-abutment connection; Screw loosening

INTRODUCTION

Developments in dental implantology evidently changed the treatment modalities over the last 25 years. However micro-gap formation between the surfaces of implant fixture and abutment is still one of the major problems at the connection area which may lead to mechanical and biological failures such as screw loosening and periimplantitis.

The screw, used to bind the implant and the abutment assisted by external, internal or morse tapered geometries, is tightened with a certain torque represented in Ncm according to manufacturers' instructions.[1] This force is transferred along the interface of the abutment, screw thread surfaces and implant thread surfaces. During the first screwing process, the torque energy is expended in smoothing the implant and abutment mating surfaces. Though this induces material fatigue according to superficial composition and/or metallurgical properties, this also provides a better harmony of the opposing surfaces which may avoid microleakage at the connection area.[2]

The mismatch of the implant and the abutment surfaces can cause rapid stress which ends up with loosening of screw[3] and also microleakage. Especially in the single crowns screw loosening is still the most frequently seen complication.[4,5] It is claimed that greater forces are required to loosen the screws with greater preloads.[6] However, even after performing essential tightening torque values, some of the researchers claimed that micro spaces still exist between these surfaces and they provoke undesirable movements, resulting in screw related mechanical failures.[7-9] These gaps also provide suitable areas for microorganism survival. Their toxins and metabolites spread into peri implant tissues. Consequently because of such microbiologic activities, a slippery environmeent altering the loosing of the

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screw may take shape. Eventually periimplantitis with the peak of inflammatory cell content especially around the implant-abutment interface related with the misfit of these surfaces cannot be impeded.[10] Several studies have been carried out examining screw loosening, microgap formation or mechanical and biological failures of dental implants.[2,10-13] But, to date little or no data exist about the relationship between the screw loosening at connections of different types of implant-abutment and microleakage.

This study aimed to evaluate the correlation between microleakage and screw loosening at connections of different types of implant-abutment and/or geometries measuring the torque values before and after the leakage tests.

MATERIALS AND METHODS

Table 1 shows the implant and abutment types used in this study. Three different abutment types with different geometries were connected to its own implant fixture according to manufacturer's recommendation in a laminar flow to avoid any contamination. All the abutments were tightened with a standard torque value of 25 Nm using a digital wrench (TQ-680; Instrutherm Mea. Ins., Sao Paulo, SP, Brasil). The implant fixtures were hold with a special device to mimic its stabilization in the bone. Then a transparent hydraulic plastic tube with 6 × 8 scales was binded to the specimen as shown in the Fig. 1 and this composition was connected to the modified fluid filtration system to perform microleakage tests.

To measure the leakage at implant-abutment interface of implant-internal hex zirconium (I-IhZ), implant-internal hex titanium (I-IhT) and implant-morse tapered titanium (I-MTtT), a modified fluid filtration method was used.[14] The parts of the filtration model (tubes, micropipettes, buffer, and etc.) were all filled with deionized water. The specimens were connected to the system using a hydraulic plastic tube. Regulated air from the pressure tank at 121.6 Kpa (1240 cm H_2O) was applied. The water in the buffer was forced to move through the interface from the threads of implant fixture and screws shown in the Fig. 1, providing to test the tightness and/or geometric harmony of implant-abutment connection. To pass in a tiny air bubble to the system a special designed microsyringe was used. Then the air bubble and the system were stabilized before measurements. Linear travelling of the air bubble through the 100 μL micropipette was then followed at a period of 20 minutes to determine the leakage quantitatively. The values were expressed as mL/min/cm H_2O.

After the measurements of leakage at the connections at the certain period of time, each sample was immediately disconnected from the system and plastic tube and dried with blotting paper. To obtain removal torque values, samples were re-inserted to the special holder. Data were used to calculate torque values using RTV/25 × 100 to express as percentages.

Kruskal-wallis test was performed for non-parametric microleakage data, and one-way ANOVA was performed for parametric torque value data (PASW Statistics for

Table 1. Shows the implant and abutment types used in this study

Implant		Abutment			Connection type	Manufacturer
Fixture	Lot No.	Height	Material	Lot No.		
3.4 x 10 mm	602908	5 mm	Zirconium	608698	Internal hex.	Medical Instinct Co. Ltd, Bovenden, Germany
3.4 x 10 mm	607899	5 mm	Titanium	607899	Internal hex.	Medical Instinct Co. Ltd, Bovenden, Germany
3.3 x 10 mm	130108A08-01	5 mm	Titanium	130111A45-01	Morse tapered	EZ, Megagen Implant Co. Ltd., Daegu, Korea

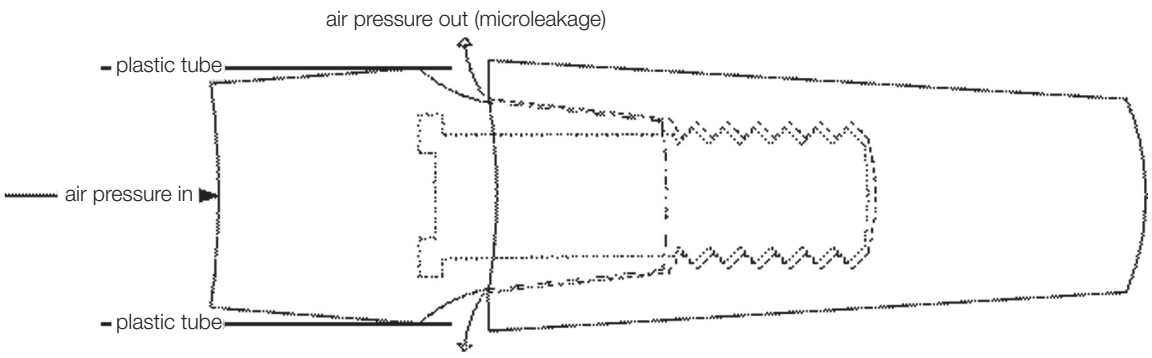

Fig. 1. Schematic view of microleakage throuh the screw threads and implant-abutment interface.

Table 2. Microleakage and loss of torque values

		Microleakage (mL)	Loss of torque value (%)
		Median ± SD	Mean ± SD
Titanium	Morse tapered	0.006 ± 0.00095[a]	9.4 ± 1.17[x]
Titanium	Internal hex	0.007 ± 0.00095[a]	10.8 ± 1.28[x]
Zirconium	Internal hex	0.034 ± 0.0038[b]	13.4 ± 2.15[y]

Tightening torque = 25 Nm (Same letters with no statistical differences)

Windows, version 18.0, SPSS, Chicago, Il, USA). Then Tukey test was used to obtain the statistical differences among the test groups. The correlation between microleakage and torque values were evaluated using Spearman Correlation Test. *P* value less than .05 was considered as significant for all the test methods.

RESULTS

The highest microleakage was found at the connection (I-IhZ), (Table 2). This result was significantly different from I-IhT and I-MtT groups. Microleakage at the connection of I-IhT was slightly higher than I-MtT connection, but this result was not statistically significant. Mean torque value loss, observed at the connection of I-IhZ was significantly higher than other connection geometries (Table 2). There were no statistical differences between losses of mean torque values at the connections of I-MtT and I-IhT.

According to the results of Spearman Correlation Test, the coefficient was found to be 0.65 which means that as the microleakage increase, the potential of screw loosening increase. This result was statistically significant at the given *P* value.

DISCUSSION

According to the results of our study it can be speculated that microleakage, through the threads of the screw and the implant and also the surfaces of implant-abutment connection, may provoke screw loosening. The tightening torque before the microleakage tests was specified as 25 Nm. However after performing the tests for definitive period mean removal torque value was degreased at least 9.4%. According to the results of our study these two components were highly correlated (0.65) which means that as microleakage between the surfaces increase this may induce loosening of the screw.

Microleakage was found to be minimum between implant and morse tapered titanium abutment surfaces. This result was parallel to the study of Pessoa *et al.*[15] They found that morse tapered geometries of connections present a better harmony and stabilization which may avoid extreme deformation of mating surfaces and microleakage. Yet none of the 2 component implant systems today can prevent fluid diffusion.[11,16] Besides, during the tightening process, opposing contacts may flatten, providing smoothened surfaces which may reduce microleakage. However this phenomenon may turn into a disadvantage when repeated tightening and removing cycles are performed by breaking down the frictional stabilization.[17]

Within the limitations in our study, we measured the removal torque value once after microleakage test. Cardoso *et al.*[12] concluded that screw loosening may pass over 20% with repeated tightening and removing cycles. Consequently detorque data may change with repetations.

The other major determinants are lubricants such as saliva, blood or microbial structures like extracellular matrix and/or slime layer that may aggravate microorganism proliferation at the connection area. These factors may alter detorque values *in-vivo* creating slippery environment. Despite there are several ways of determining microleakage at the connection area[16,18-20] we used a modified filtration method *in-vitro* to mimic a lubricated surface using deionized water with pressure.[14]

Detorque value is expected to be the same as tightening value at perfect connections. However, it may be difficult to achieve according to many researchers.[13,17,21] This is compatible with our study that removing torque values decreased more than 9% of tightening value. Under the same test conditions the decreased percentage was higher at implant-ceramic abutment connection possibly due to the worse mating surfaces compared with titanium.

Biocompatibility and aesthetic are the primary reasons for choosing ceramic materials in dental practice. Nevertheless as microleakage at I-IhZ connection is about 5 times greater than the titanium connection in certain *in-vitro* study, a different point of view can arise. Grater values may be due to the milled surface of the zirconium abutments rougher than the titanium which avoids mating of the surfaces as discussed. It is known that such rough surfaces offer suitable areas for microorganism adhesion and/or colonization.[22,23] Afterward oral microorganisms may easily invade through the periimplant areas with the aid of their own extracellular products, forming slippery environment as discussed. This process can cause failure of the implant along with soft and/or hard tissue loss. Consequently this may be commented as a deficit of ceramic material.

CONCLUSION

It may be speculated that microleakage provokes screw loosening therefore removing torque values rationally decrease with the increase of microleakage. The rougher surface of ceramic abutments compared with titanium abutment may turn the aesthetic advantageinto a deficit due to lubricants and ease of adhesion of microganisms. Removing torque values only reached up to 91% of the tightening torque values.

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