

Efficacy of Antibacterial Sealing Gel and O-Ring to Prevent Microleakage at the Implant Abutment Interface: An In Vitro Study

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Gaps and hollow spaces at the implant abutment interface will act as a bacterial reservoir that may cause peri-implantitis. Hence, the sealing ability of O-ring (in addition to polysiloxane) and GapSeal (an antibacterial sealing gel) was evaluated. A total of 45 identical implant systems (ADIN Dental Implant Systems) were divided into 3 groups of 15 implants each: an unsealed group, a group sealed with O-rings, and a group sealed with GapSeal gel. The implant and abutment were gamma sterilized after assembly. Two implants from each group were randomly incubated in sterile brain heart infusion (BHI) broth tubes and checked for sterility. The remaining 13 implants were incubated in BHI broth inoculated with *Enterococcus* and incubated for 5 days. They were then removed from the tubes, dried aseptically, placed in 2% sodium hypochlorite solution for 30 minutes, and washed with sterile saline for 5 minutes. Next, the assembly was dried aseptically and put in sterile BHI broth tubes and incubated for 24 hours to check surface sterility. Keeping 2 implants as controls from each group, the remaining 11 implants were dismantled group-wise and placed in liquid BHI broth; the test tubes were then shaken thoroughly so that the broth would come in contact with all implant surfaces. The solution from this tube was poured on pre-prepared sterile agar plates and incubated for 24 hours. The colonies formed on the agar plate were then counted using a digital colony counter. The data thus obtained were subjected to statistical analysis by Kruskal-Wallis analysis of variance and Mann-Whitney *U* test. It was concluded that though microbial growth is seen in all the 3 groups, the least growth was seen in the GapSeal group followed by the O-ring group.

Key Words: *implant-abutment interface, micro gap, O-ring, GapSeal*

INTRODUCTION

The use of implants has increased because of their high success rate. The most commonly feared complication in implantology is peri-implantitis, which usually leads to loss of supporting crestal

bone if it remains untreated.¹ Various factors have been reported to cause peri-implantitis, one of the most common of which is microleakage at the implant abutment interface. Most implants consist of 2 pieces, an implant and an abutment; the junction between them is the implant abutment interface (IAI), which has been a subject of debate. Several authors have implicated the IAI contributes to crestal bone loss.² This has been attributed to the gap between implant and abutment in a two-piece implant system. The poor fit may lead to microleakage of fluids and harbor bacteria, which in turn

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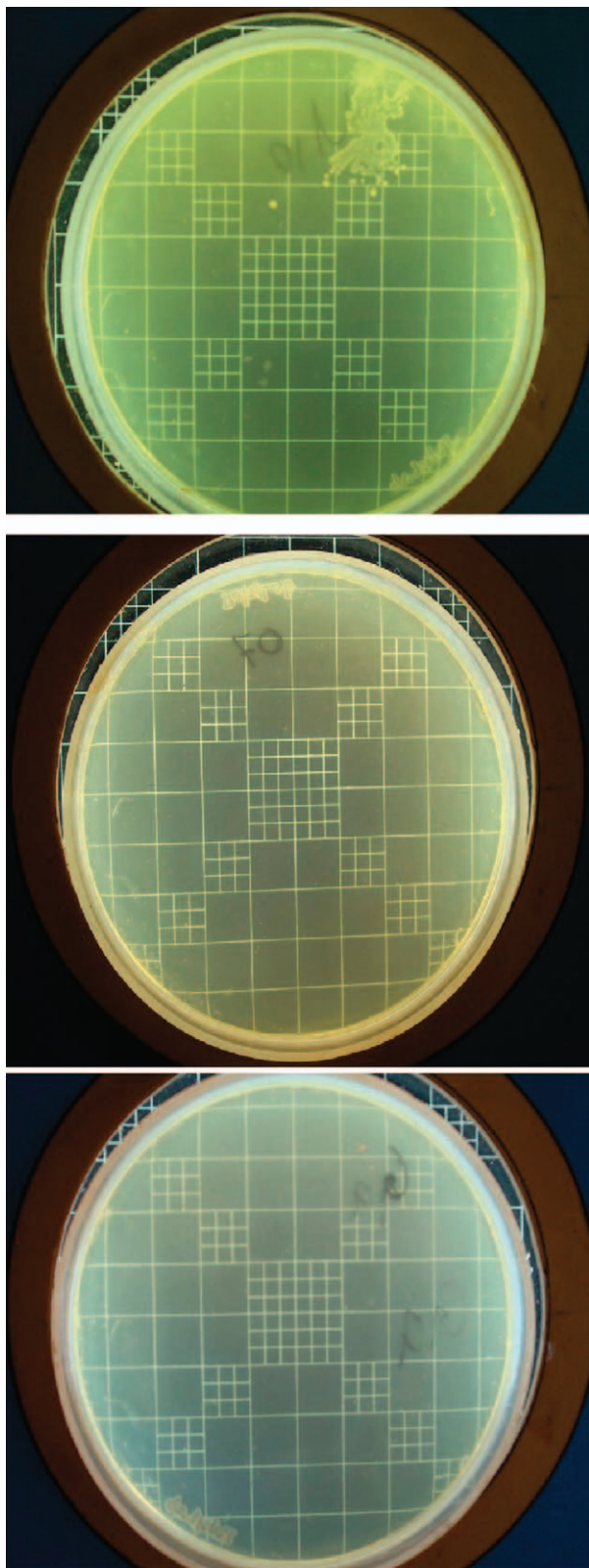


FIGURE 1. Agar plates of the U, O, and G groups, respectively, placed on a digital colony counter. U indicates unsealed group; O, group sealed with an O-ring; G, group sealed with GapSeal.

TABLE 1
Number of colony-forming units per milliliter for the 3 groups*

Summary	Unsealed Group	O-Ring Group	GapSeal Group
Mean	187.64	72.55	3.18
SD	42.31	63.62	3.46
SE	12.76	19.18	1.04

*SD indicates standard deviation; SE, standard error.

may lead to peri-implantitis.² To seal the gap, O-ring, a polysiloxane ring, and GapSeal, an antibacterial sealing gel, have been recommended. The present study was performed to evaluate the efficacy of these sealing agents for preventing the microgap at the IAI.

MATERIALS AND METHODS

The experiment was performed using 45 implants (ADIN Dental Implant Systems Ltd, Afula, Israel) to check the efficacy of sealing agents at the IAI. The implants were divided into 3 groups of 15 implants each: a group that used no sealing agent at the IAI, a group that used an O-ring (ORMCO, Milan, Italy) at the IAI, and a group that used GapSeal (Hagerwerken, Duisburg, Germany) at the IAI. The implants and abutments were assembled using a torque of 20N by stabilizing them in a C-clamp (J.K. Enterprises, Hubli, India). The assembly was then gamma sterilized (Microtrol, Bangalore, India).

After sterilization, 2 assembled implants from each group were randomly taken and incubated in brain heart infusion broth (BHI broth, Microexpress, Goa, India); one was incubated without dismantling and the other was dismantled. The incubation was carried on for 48 hours to ensure complete sterilization of the implant-abutment assembly. The

TABLE 2
Comparison of the colony-forming units per milliliter for the 3 groups according to Kruskal-Wallis analysis of variance by ranks*

Group	Mean	SD	Sum of Ranks	H Value	P Value
Unsealed group	187.64	42.31	300.00	23.2314	.0000*
O-ring group	72.55	63.62	178.00		
GapSeal group	3.18	3.46	83.00		

*U value indicates Mann Whitney U test values; Z, standard normal variant.

TABLE 3

Pairwise comparison the colony-forming units per milliliter for the 3 groups according to Mann-Whitney *U* test

Group	Mean	SD.	Sum of Ranks	U Value	Z Value	P Value
Unsealed group	187.64	42.31	179.0000			
O-ring group	72.55	63.62	74.0000	8.0000	-3.4474	.0006
Unsealed group	187.64	42.31	187.0000			
GapSeal group	3.18	3.46	66.0000	0.0000	-3.9727	.0001
O ring group	72.55	63.62	170.0000			
GapSeal group	3.18	3.46	83.0000	17.0000	-2.8564	.0043

remaining implant-abutment assemblies from each group were then immersed in the test tube containing BHI broth, inoculated with enterococci, and incubated in an incubator (Tempo Company, Mumbai, India) for 120 hours at 37°C. After incubation the assembly was removed from the test tubes and the surfaces washed with 2% freshly prepared hypochlorite solution (S.M. Pharmaceuticals, Bangalore, India) for 30 minutes and then with saline solution (Nirmal Ltd, Gujrat, India) for 5 minutes under sterile conditions in Bio Safety Cabinet (Kartoa International, Noida, India). To check the efficacy of the surface decontamination procedure, all 13 implants were further incubated in sterile BHI broth for 24 hours. Eleven implants from each group were then dismantled and again placed in sterile BHI broth; the test tubes were well shaken to ensure adequate contact of the broth with the interior of the implants. Then, 5 mL from each test tube was poured on pre-prepared sterile agar plates and incubated for 24 hours. The colonies formed on the agar plate were

then counted with a digital colony counter (Serwell Instruments, Bangalore, India; Appendix).

RESULTS

The number of colonies in each group ranged from 123 to 262 (mean, 187.64; standard deviation [SD], 42.31). The number of colonies in the O-ring group ranged from 0 to 183 (mean, 72.55; SD, 63.62). The least variation in colony forming units was observed in the GapSeal group, in which the number of colonies ranged from 0 to 9 (mean, 3.18; SD, 3.46).

The basic data for all groups were subjected to statistical analysis using Kruskal-Wallis analysis of variance; a statistically significant value was seen where the *P* value was .0000 ($P < .01$, significant at a 5% level significance). Further pairwise comparison was done using Mann-Whitney *U* test, which showed statistical significance at the 5% level for the unsealed and O-ring groups ($P = .0006$); statistical significance was also shown at the 5% level for the unsealed and GapSeal groups ($P = .0001$) and the O-ring and GapSeal groups ($P = .0043$) (significant at a 5% level of significance [$P < .01$]).

DISCUSSION

This study shows that a complete seal is not found at the IAI, and the presence of sealing agent helps reduce microleakage. The bacteria that grow at the IAI will colonize and percolate through the microgap into the space within the implant that will act as a reservoir.³ Thus, this study clearly highlights that there is a leakage at the IAI and a complete hermetic seal is not possible. This is in accordance to a study done by Gross et al,⁴ Jansen et al,⁵ Traversy et al,⁶ and Quirynen et al.⁶ However, the leakage of the bacteria can be reduced to a negligible number by using a gel rather than an O-ring. The gel's low viscosity allows it to flow

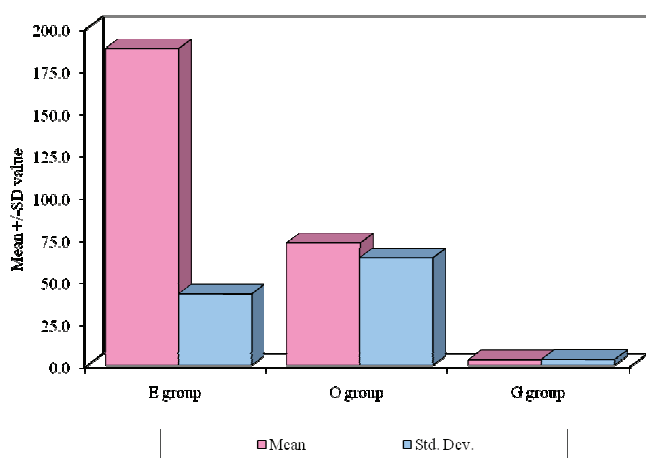


FIGURE 2. Graph comparing 3 groups (unsealed, sealed with an O-ring, and sealed with GapSeal) with respect to mean colony-forming units per milliliter.

easily throughout the IAI, leading to a better seal than the O-ring. Unlike the low viscosity gel, the O-ring's body prevents complete seating of the abutment. The rubber can deteriorate over time, which may increase leakage. Further evaluation is needed about this as well as about the longevity of the gel and the use of an antimicrobial along with the gel. The leakage without a sealing agent was probably due to the lack of complete wall-to-wall adaptation between abutment and implant. In addition, as time passes there will definitely be an effect on screw tightening, which may lead to subsequent deformation and increased microleakage.

The methods used to tighten the implant abutment connection and subsequent retaining screw deformation may also influence leakage.⁷ The degree of leakage found was dependent on the closing torque. There was an inverse correlation between the degree of closing torque and severity of the leakage. In the present study, a 20N torque was achieved, the amount recommended in the oral cavity, by holding the body of the implant in a C-clamp for stability. During this procedure there is a chance that the implant body will shift in the clamp; therefore, the force applied may not always have been sufficient, and the screw may have loosened, leading to contamination of the implants. Less leakage has been observed with higher torque intensity.

ABBREVIATIONS

BHI: brain heart infusion
IAI: implant abutment interface

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APPENDIX			
Colony-forming units per milliliter as counted on a digital colony counter			
Samples	Unsealed Group	O-Ring Group	GapSeal Group
1	123	183	0
2	201	68	9
3	150	0	0
4	152	105	0
5	225	0	8
6	187	102	4
7	206	176	5
8	202	64	6
9	138	50	0
10	262	130	3
11	218	50	0