Evaluation of adhesive strength between resin and titanium with a primer containing a silane coupling agent

/Kimura H[1], Kato T[1,2], Saigo K[2], Yamada B[1], Yamauchi J[1], Yamamoto S[1] ([1] Yamamoto Precious Metal Co., Ltd., [2] Kochi University of Technology): For the Ti abutment of an implant superstructure, surface treatment with a suitable primer is required. In this study, TWiNY Repair Primer (Yamamoto Precious Metal, TR1) and an opaque resin (TWiNY IvO) containing γ-methacryloyloxypropyltrimethoxysilane (γ-MPTS) as a coupling agent (TR2) were employed in order to evaluate adhesion with a resin and to compare the adhesion of commercially available primers for Ti. The results obtained have demonstrated that TR1 and TR2 containing γ-MPTS are as effective as the commercially available primers.

[Abstract]
Dental treatment using implants mainly employs titanium out of considerations of biocompatibility. When constructing with resin to create a superstructure for the titanium, surface treatment using a primer is required. In recent years, interest has been aroused by reports of improved adhesiveness to the resin by means of bonding to the titanium surface using a silence coupling agent [1), 2)].

In this investigation, TWiNY Repair Primer (TR1), containing the silane coupling agent γ-Methacryloyloxypropyltrimethoxysilane (γ-MPTS) is used in the surface treatment of titanium, along with an opaque resin trial product (TR2). The investigation compares the adhesive strength of the resin against that achieved using a range of commercially available primers.

[Materials and Methods]
For the adhesion test, φ6 mm of pure titanium (JIS-compliant, 4 sources, manufactured by Shinsho Corporation) was polished using No. 600 sand paper, and after alumina sandblasting, the bonding plane area was regulated by means of affixing tape with pores of φ 3 mm in diameter. Surface treatment was conducted on the bonding plane area using TR1, TR2 and six commercially available primers, after which an opaque resin (TWiNY IvO, manufactured by Yamamoto Precious Metal) was thinly applied and curing was conducted by means of photopolymerization. A stainless steel rod (diameter φ5 mm, length15 mm) was then affixed using resin cement (PANAVIAF 2.0, manufactured by Kuraray Medical)

In this investigation, adhesion testing with titanium was also carried out not only on TR1, which is an ethanol solution of γ-MPTS (manufactured by Momentive Performance Materials Japan), but also on TR2 with γ-MPTS added to the TWiNY IvO. Table 1 gives the components of TR1, TR2 and the six commercially available primers (A-F).

Table 1. Primers used for titanium adhesion

Component	Trial primer		Commercial primer					
	TR1	TR2	A	B	C	D	E	F
Silane coupling agent	○	○	○	○	—	—	—	—
P-OH containing monomer	—	—	—	○	○	○	○	○
S containing monomer	—	—	—	○	○	○	○	—
Carboxylic acid monomer	—	—	—	—	—	—	—	○
Resin paste	—	○	—	—	—	—	○	—

After being immersed in distilled water for 24 hours at 37 ˚C, the test specimens were tested for adhesive strength by means of a tensile test conducted using a small-sized universal tester (Ez-Graph, manufactured by Shimadzu). Using the same means, the adhered test specimens were subjected to a tensile test following thermal cycling (4 ˚C and 60˚C, 1 minute, 5,000 cycles); durability was evaluated from the changes in observed adhesive strengths.

[Results]
Figure 1 gives adhesive strengths before and after thermal cycling depending on the primer used. With the use of TR1 and TR2, the primer component of which consists of γ-MPTS only, adhesive strength shows a clear increase in comparison to cases where primer is not used, and adhesion both before and after thermal cycling is equal or superior to that of the preparations using the commercially available primers.

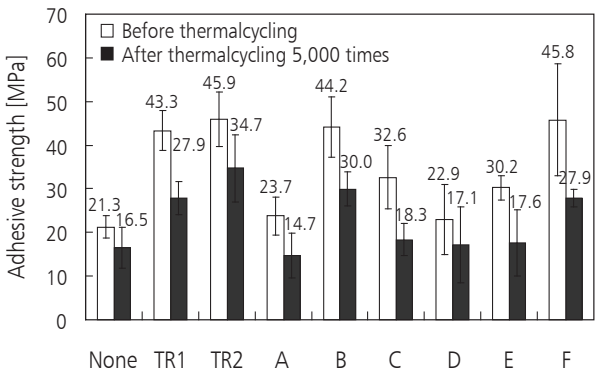

Fig.1 Effects of thermal cycling on adhesive strength

[Discussion]
Under exposure to the atmosphere, titanium easily forms an oxidized surface layer, and in reaction to atmospheric water content, the surface is covered by hydroxyl(-OH)[3]. It is thought that by forming a covalent bond (Ti-O-Si) through reaction to the titanium surface in this way, γ-MPTS makes possible a firm adhesion with the resin.

The results of this investigation demonstrate that the use of TR1 and TR2, the active component of which is γ-MPTS only, in adhesion between titanium and resin achieves adhesive strength equivalent or superior to that achieved using the commercially available primers.

[Reference]
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