Stability of the Screw Joints in Patients with Implant-Supported Fixed Prostheses in Edentulous Jaws: A 1-Year Follow-up Study

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Purpose: The purpose of this follow-up study was to evaluate the stability of the screw joint in edentulous patients 1 year after treatment with implant-supported fixed prostheses (Brånemark system). ***Materials and Methods:*** A total of 20 patients were included, 10 treated in the maxilla and 10 in the mandible. The fixed prostheses were removed approximately 1 year after insertion, and the stability of the screw joints was evaluated using a rating scale based upon the CDA quality evaluation criteria of dental care. ***Results:*** All implant-supported fixed prostheses were recorded as stable before the prosthetic screws (gold screws) were unscrewed. "Unacceptable loosening" was observed in 4% of the prosthetic screws and in 29% of the abutment screws. ***Conclusion:*** In this study, only a few of the prosthetic screws showed unacceptable loosening after 1 year of function. The clinical relevance of the observed high occurrence of loose abutment screws could be questioned, as all fixed prostheses were initially recorded as stable. *Int J Prosthodont 2004;17:177–180.*

Treatment with fixed reconstructions on osseointegrated implants has improved the quality of life of edentulous patients and has been used for more than 30 years.[1] Mechanical complications, such as fractures of the gold screws and abutment screws, have been observed in 1.5% to 3.0% of patients in a 15-year follow-up study of implant-supported fixed prostheses (ISFP) in edentulous jaws.[2] Fracture of the abutment screws was observed in 1% in another retrospective study of implant-supported prostheses,[3] and the same frequency (1%) was observed in another follow-up study of ISFPs with laser-welded titanium frameworks.[4] The occurrence of loose screw joints in ISFPs and the various degrees of joint loosening have been presented earlier.[5,6]

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A number of factors influence the stability of the screw joint: design, rigidity, and fit of the framework, number of implants included, length of the cantilever, design and tightening of the screw, and occlusal loading forces.[7–9] The type of opposing material and type of occlusion also seem to influence the stability of the screw joint, as more screw loosening is observed when the ISFPs occlude complete dentures.[10] Another factor to consider may be "nocturnal bruxism" because more loose and/or fractured abutment/gold screws were observed in patients with such parafunction than in other persons in one study.[11]

The purpose of the present follow-up study was to evaluate the stability of the screw joint 1 year after treatment of edentulous patients with ISFPs.

Materials and Methods

Study Population

The study subjects comprised 20 completely edentulous patients treated at the Dental and Medical Health Centre, Halmstad, Sweden, between 1996 and 1998 (Table 1). Implant treatment followed the standard (two-stage) protocol of the Brånemark system (Nobel

Table 1 Study Population and Distribution of Implants and Abutments Used in Fabrication of Implant-Supported Fixed Prostheses

Variable	Maxilla	Mandible
No. of patients	10	10
Mean age (y)	66	67
Age range (y)	50–78	51–73
Women/men	3/7	4/6
No. of implants supporting prosthesis		
4	—	2
5	4	7
6	5	1
8	1	—
Implant length		
10 mm	8	4
13 mm	27	12
15 mm	23	33
Abutment length		
1 mm conical	19	—
2 mm conical	9	—
3 mm conical	3	—
3 mm standard	18	24
4 mm standard	5	11
5.5 mm standard	—	10
7 mm standard	—	4
17° angulated	4	—

Biocare), and the patients were all rehabilitated with ISFPs. The prostheses were fabricated either with a framework of titanium (7) or gold (11) and acrylic resin teeth. Two prostheses were made of metal ceramic. The mean length of the cantilever was 11 mm (range 3 to 16 mm) in the maxilla and 14 mm (range 5 to 19 mm) in the mandible. All patients with an ISFP in the maxilla either had a natural dentition or a tooth-supported fixed prosthesis in the mandible. Seven patients with an ISFP in the mandible had a removable complete denture, two patients had a natural dentition, and one patient had an ISFP in the opposing jaw.

Before insertion of the prostheses, the conical abutments were tightened with an electric torque driver (Nobel Biocare DEA 020) to 20 Ncm. The standard and angulated abutments were all tightened manually. The gold screws, all with a flat design, were tightened to 10 Ncm. Approximately 2 weeks after prosthesis insertion, all gold screws were retightened before permanent sealing of the access hole. In all, 107 implants were included in the study.

Prosthesis/Implant Stability and Screw Joint Loosening

One examiner made the recordings at the first annual check-up approximately 12 months (range 9 to 13 months) after insertion of the fixed prosthesis. The prosthesis stability was checked manually before removal. After removal of the seal to the access hole, the tightness of the gold and abutment screws was evaluated using a rating scale based upon the California Dental Association's (CDA) quality evaluation criteria of dental care[5,12]:

- R = no loosening: Individual screw is absolutely impossible to tighten manually with a screwdriver.
- S = slight loosening: Screw is not obviously loose, but it is clearly possible to increase the strain against continuous resistance.
- T = obvious loosening: Screw can easily be rotated up to half a turn without obvious resistance, but friction can be continuously felt during tightening.
- V = extreme loosening: Screw has to be rotated before reaching friction. No resistance can be felt at applied manual torque.

R and S ratings were considered "satisfactory," while T and V ratings were considered "not acceptable." All the gold screws had a flat head with a slot.

Results

All prostheses and implants were stable at the annual check-up. The tightness of the screw joints was evaluated in all 20 prostheses (Table 2). "Not acceptable loosening" was observed in 4% of the gold screws (prosthetic screws). However, 29% of the abutment screws showed "not acceptable loosening." No correlation could be observed between the tightness of the screw joint and the type of abutment (standard or conical) or the length of the cantilever of the fixed prostheses.

Discussion

The present study was a part of another study presented earlier,[13] the purpose of which was to quantify the change in the peri-implant mucosal level 1 year after treatment of edentulous patients with ISFPs. This was the reason the fixed prostheses were unscrewed.

The screw joints showed various degrees of loosening. A 5-year follow-up study of ISFPs[5] found that 40% of the gold screws were loose to an unacceptable extent. The gold screws in that study had a conical design. In the present study, only 4% of the gold screws showed unacceptable loosening. A possible explanation for this is that the gold screws were tightened with a torque driver to a 10-Ncm force and had a flat design, which increases the holding capacity of the screw joint.[8] In another study,[6] the screw joint was tested in the same way for partial ISFPs. There, the prostheses with cantilevers showed "not acceptable loosening" of the gold screws in 12%, compared to 0% in the prostheses without cantilevers. However, all

Table 2 Tightness of Screw Joints in All 107 Implants: n (%)

Screws	Satisfactory		Not acceptable	
	R	S	T	V
Gold				
Maxilla	49 (84)	8 (14)	1 (2)	–
Mandible	39 (80)	7 (14)	3 (6)	–
Total	88 (82)	15 (14)	4 (4)	–
Abutment				
Maxilla	26 (45)	11 (19)	21 (36)	–
Mandible	12 (24)	27 (56)	8 (16)	2 (4)
Total	38 (36)	38 (36)	29 (27)	2 (2)

the fixed prostheses were designed with cantilevers in the present study.

Kallus and Bessing[5] reported unacceptable loosening in 3.6% of the abutment screws, compared to 29% in the present study. One explanation for the unsatisfactory loosening of the abutment screws could, of course, be inadequate tightening.[8] Another explanation is that the prosthetic gold screw and abutment screw form one unit once the prosthetic gold screw is tightened. The tightening of the gold screw will clamp the abutment between the fixed prosthesis with the incorporated gold cylinder and the implant. As the prosthetic gold screw is tightened, a preload is built up in the stem of that screw. A typical preload for a titanium abutment screw (eg, Standard Regular Platform, Nobel Biocare), tightened with 20 Ncm, is 180 N, and is somewhat higher for the "conical" abutment.[14] Because of the lower friction between the gold alloy and titanium compared to the friction between titanium and titanium, a larger preload may occur, although the tightening torque is lower for the gold screw. Should this occur, the abutment screw will be released from the seating surface between the abutment and the abutment screw, and the abutment and the two screws will act as one screw from a mechanical point of view. As long as the prosthetic gold screw is tight, the abutment will also be tightly secured. Therefore, one may question the clinical relevance of the loose abutment screws observed in the present study. This theory is also supported by the fact that all fixed prostheses were recorded as stable before removal.

In a 3-year follow-up study of milled titanium frameworks for ISFPs in edentulous jaws, no loose or fractured screw components were seen.[15] One could speculate as to whether the excellent fit of the milled titanium framework will result in fewer mechanical complications, and some in vitro studies support this theory[16]; to our knowledge, however, this has not been confirmed in any long-term follow-up study. The consequences of misfit to implant survival have often been discussed, but contrary to the common opinion that it is detrimental, the misfit preload even seemed to increase the bone-to-implant contact in a study in rabbits.[17]

The problem with loosened gold screws (prosthetic screws) is probably universal for most of the implant systems available on the market, but there is continuous development in this area. Prosthetic screws with treated surfaces that reduce the coefficient of friction between the materials seem to produce greater retention in the screw joint compared to conventional gold alloy screws, and this will probably diminish this problem.[18]

In the present study, only a few of the prosthetic screws (gold screws) showed unacceptable loosening after 1 year of function. The clinical relevance of the observed high occurrence of loose abutment screws might be questioned, as all fixed prostheses were initially recorded as stable.

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Literature Abstract

A new adhesive technology for all-ceramics.

Alumina and zirconia ceramics are not etchable with hydrofluoric acid, which may prevent effective cemenation using the adhesive technique. PyrosilPen technology involves a small hand-held lighter containing a mixture of butane gas and tetraethoxy silane. The cemented surface of ceramics is flame treated for a few seconds, resulting in a surface coated with SiO_x–C fragments bonded to the ceramic by van der Waals forces. This glass-like layer is silane treated using a solution of 3-methacryloyl oxypropyl trimethoxy silane in an organic solvent before application of a luting agent. These procedures result in bonding of the luting agent to the ceramics that may enhance retention. Four ceramic systems—Empress 2, In-Ceram Alumina, In-Ceram Zirconia, and Degussit Frialit ZrO_2—were studied. Three groups of 10 samples were fabricated for each ceramic system. They were polished to 800 grit, air dried, and flame treated for 5, 10, and 20 seconds, respectively, using PyrosilPen technology. Low-viscosity resin was applied to the treated surface, followed by a luting agent light cured for 40 seconds. The control was samples of Empress 2 etched and silanized conventionally. All specimens were thermocycled 5,000 times in water between 5 and 55°C. Shear bond strengths of Empress 2 and In-Ceram Alumina were significantly higher than In-Ceram Zirconia and Degussit Frialit ZrO_2. There was no significant difference among the treatment times in each ceramic system. When comparing the two cementation methods in Empress 2, shear bond strength of group 2 (flame treated for 10 seconds on a 2 cm^2 area) using PyrosilPen technology was comparable to the control, whereas groups 1 and 3 were significantly lower. Although Degussit Frialit ZrO_2 showed significantly lower shear bond strength than the other systems, group 2 of this system was not significantly different from the control. Since the results of group 2 for all four ceramic systems were comparable to the control, the authors concluded that flame treating the surface for 10 seconds is the optimal treatment time for a 2 cm^2 area and noted the potential of this technology for cementing zirconia ceramics. More studies need to explore this technology before concrete conclusions can be drawn.

Janda R, Roulet JF, Wulf M, Tilklker HJ. *Dent Mater* 2003;19:567–573. **References:** 54. **Reprints:** Dr J. F. Roulet, School of Dental Medicine, Humbolt-University Berlin (Charité), D-13353 Berlin, Germany. Fax: + 49-30-450-562-961. e-mail: jfroulet@aol.com—*Kok-Heng Chong, Ann Arbor, Michigan*