Multicenter Retrospective Analysis of the ITI Implant System Used for Single-Tooth Replacements: Results of Loading for 2 or More Years

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This report involves the retrospective evaluation of ITI implants placed by a group of 12 clinicians located throughout the United States. Of the original 174 single implants placed in 129 patients reported previously, 157 were examined in 110 patients after 2 or more years (average 40.1 months). Twenty-two implants remained in the anterior and 135 implants (86%) remained in the posterior areas of the mouth, with 81 being restored with an octabutment screw-retained crown and 76 restored with a conical-abutment cemented crown (in function 2 years or longer). Occlusal screw loosening was observed in 22.2% of implants over both periods, with only 1 tooth loosening in both study periods (6 months to 2 years and ≥ 2 years). Loosening of a solid conical abutment occurred in 1 additional patient, for cumulative conical abutment loosening of 5.3%. Significant radiographic bone loss was observed around 4 implants, with implant fracture noted with 3 additional implants (all mandibular first molars with hollow-screw or hollow-cylinder implant design). The survival rate at ≥ 2 years was 95.5%. The data suggest that ITI implants can be a satisfactory choice for posterior single-tooth restorations. (Int J Oral Maxillofac Implants 1999;14:516–520)

Key words: implant fracture, implant survival, ITI implant, multicenter study, single-tooth implant

The success of osseointegrated implants is well-documented in the dental literature for all applications, ie, complete edentulism,[1] partial edentulism,[2,3] and more recently, single-tooth applications.[4–6] With more patients currently desiring retention and treatment of existing teeth versus extractions and conventional dentures, it is only logical that there is a desire to replace single-tooth gaps with single implants, rather than altering adjacent teeth with the placement of a conventional fixed prosthesis. The demand for single endosseous osseointegrated implants will undoubtedly increase in the coming years. This valuable service enables the patient to enjoy the benefits of comfortable function, pleasing esthetic results, freedom from recurrent caries concerns involving these restorations, lack of oral hygiene compromise and retention of the ability to floss easily, and most importantly, the replacement for the patient what was originally lost: a single tooth.

Preliminary results in a multicenter retrospective study[5] involving 174 single-tooth ITI implant restorations suggested favorable survival rates (97.7% success) and high patient satisfaction (92.9%), as described from a short questionnaire completed for 155 of the 174 implants. Not only were survival rates for anterior and premolar areas reported, but also molar areas, where a single, lone-standing implant is most severely tested under many types of forces of occlusion, mastication, and possibly parafunction.

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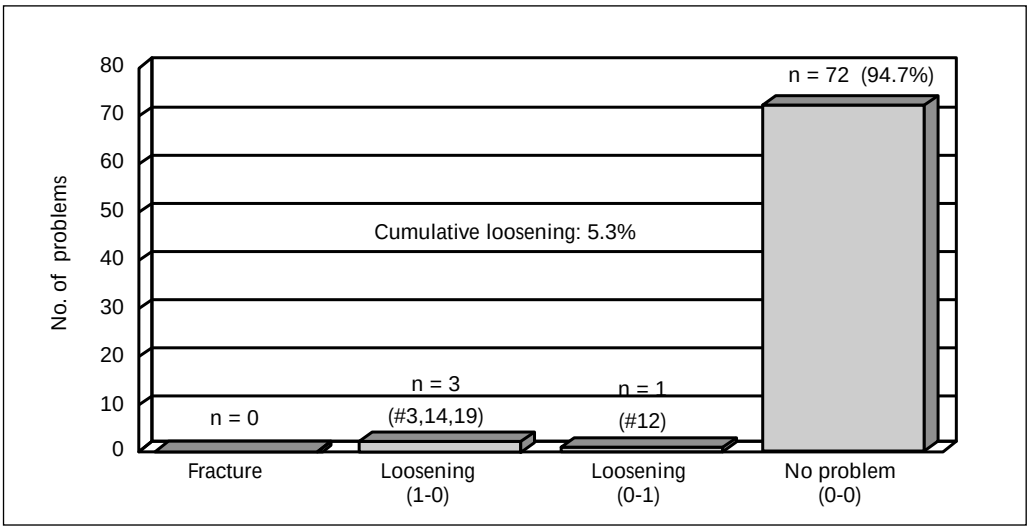

Fig 1 Abutment cylinder problems at 2 or more years (mean 40.1 months) after loading for cemented crown restorations (n = 76). 1-0 = loosening seen once in first study period (≥ 6 mo) and none seen in second study period (≥ 2 y loading); 0-1 = no loosening seen in first study period (≥ 6 mo) and loosening seen once in second study period (≥ 2 y); 0-0 = no loosening seen in either first or second study period.

The purpose of this follow-up study was to evaluate the survival of the remaining ITI implants that were able to be followed after 2 or more years of loading. In addition, the survival of cemented versus screw-retained single implant–supported crowns was compared.

Materials and Methods

This multicenter retrospective study of single-tooth ITI implants was first reported in 1997.[5] The study commenced with 174 implants placed in 129 patients in 12 private practices in the United States. Following at least 6 months of loading, a total of 4 failures (97.7% survival rate) were noted. The failures were associated with peri-implantitis. These implants have now been followed for 2 or more years after loading, with final examination and radiographs completed by the spring of 1997. Complications were recorded as they occurred and included loosening of conical abutment cylinders (or fracture for cemented restorations), fracture of crown-retaining screws (or loosening for screw-retained restorations), loosening of octabutments for screw-retained restorations, marginal bone loss, implant failure, and implant fracture.

Results

Of the original 129 patients who agreed to participate in the study, 110 were available for evaluation after 2 (or more) years. Reasons for the loss of 19 patients (14.7%) to follow-up included: death (n = 3), connection of the implant to tooth as a prosthesis abutment (n = 2), unable to contact (n = 8), moved away from the area (n = 6).

Implant Survival. The clinical examination after 2 or more years (mean 40.1 months) revealed that 157 implants remained in 110 patients. Four implants failed after 6 or more months because of peri-implantitis. No additional failures related to peri-implantitis were noted. However, 3 additional failures were found to be the result of fractures of previously healthy implants. All 3 fractures were in the mandibular first molar area with a hollow (3.5-mm-wide) implant being used. The implant failures occurred after a mean of 40.3 months. None of the solid-screw (4.1-mm-diameter) implants fractured. The overall survival rate was 95.5%.

Restorative Failure and Problems. Of the 157 implants that remained after 2 or more years, 22 were placed anteriorly and 135 posteriorly. Eighty-one were screw-retained with octabutment and 76 were cemented with conical abutment cylinders.

Problems with conical abutment cylinders were minimal, with only 1 additional cylinder becoming loosened, requiring retightening and recementation of the crown (maxillary left first premolar) at 2 years. Added to the 3 conical abutment cylinders that had already loosened (during the initial study), the overall incidence of conical abutment cylinder loosening was 5.3% over the 2 study periods (Fig 1).

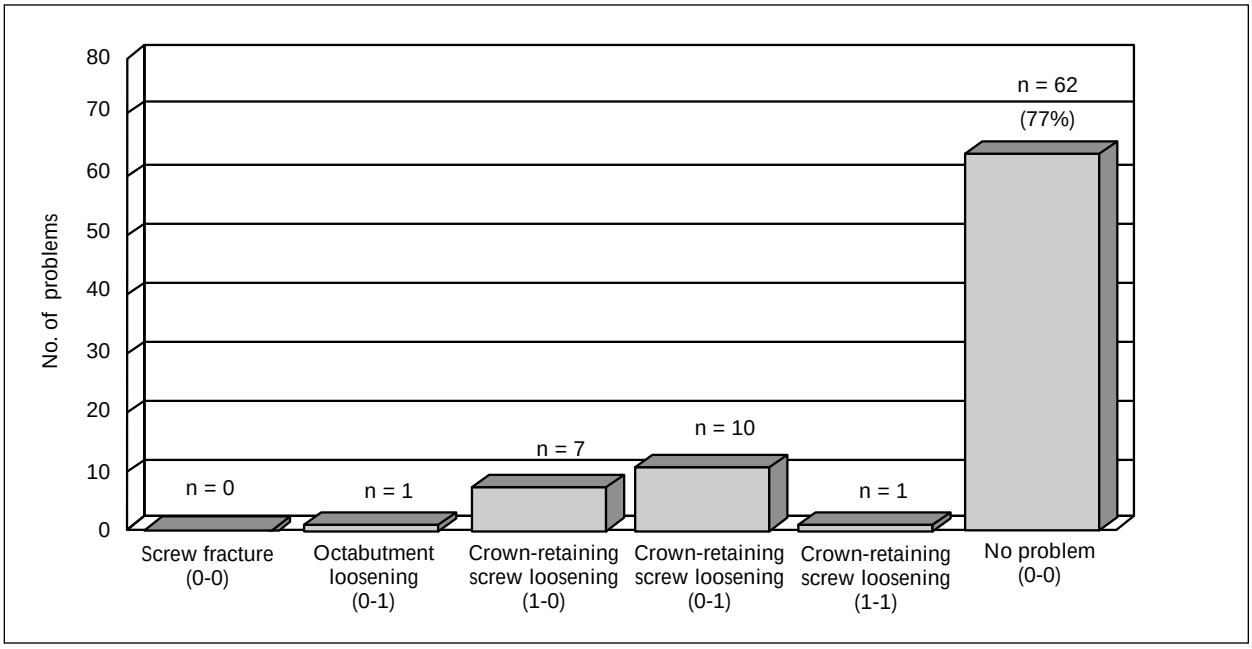

Fig 2 Crown-retaining screw problems at 2 or more years after loading (screw-retained restorations with octabutment, n = 81). 1-0 = loosening seen once in first study period only (≥ 6 mo); 0-1 = loosening seen once in second study period only (≥ 2 y); 1-1 = loosening seen once in both study periods; 0-0 = no loosening seen in either study period.

The only crown failures in this group were the original 3 from this patient. The only other problem with a cemented crown was 1 loosening because of decementation (washout) after 1½ years. This tooth was recemented with no subsequent problems. In addition, a screw-retained crown (mandibular left first molar) needed to be remade because its screw seat was stripped.

Octabutment loosening was seen in one patient (mandibular left first molar) after the crown had been in place for over 3 years. The patient admitted that the screw-retained crown had been loose for over 3 months prior to returning to her restorative dentist for evaluation (Fig 2).

Loosening of crown-retaining screws was seen associated with 11 teeth. Added to the 7 teeth that became unscrewed, this resulted in a total of 18 screw-retained restorations that required retightening. Only the restoration at the maxillary right lateral incisor loosened more than once (×2). No fractures of retaining screws were noted. The overall incidence of crown-retaining screw loosening was 22.2% (40.1 months average) (Fig 2).

Discussion

The ideal implant and its restoration will be maximally tested under all types of occlusal loads and conditions in posterior areas, where maximum occlusal forces are endured. An implant's survival, to be accurately reported in a single-tooth application, should therefore be tested under the abovementioned conditions. The survival rate of the ITI implant, used as a single-tooth replacement in the present study, was 95.5% for 157 implants in 110 patients, with 22 placed anteriorly and 135 placed posteriorly. Eighty-six percent of the 157 implants were placed posteriorly, with 75 being placed in molar areas and 60 in premolar areas. The survival rate of the molar population was 92%, whereas the survival rate of the premolar population was 99.98% (1 failure). Fracture of implants was seen only in the molar region, specifically in the mandibular first molar area, for a 4% fracture rate in all molar areas and an overall 1.9% fracture rate for all implants in the study.

No fractures of solid-screw implants were noted, and this fact has also been noted by other researchers for the 4.1-mm-diameter implant.[3] Based on this information, the use of solid screws 4.1 or 4.8 mm in diameter would be preferable in the posterior areas of the mouth to avoid this possible complication (unpublished data). The analysis of fractured implants brought to light some interesting observations. The fractures seen were site-specific to the mandibular first molar area in 3 sep-

arate patients. Each fracture occurred with the hollow-cylinder design and seemed to initiate 2½ years after being loaded (as noted). One patient was a known bruxer.

Three fractures were also noted (2 hollow-cylinder implants and 1 hollow-screw implant) by Buser et al.[3] They noted at the fifth and sixth years, fractures occurred because of fatigue at the weakest point of these hollow-body implants (the first row of perforations) when advanced bone loss occurred. In addition to minimizing potential mechanical risks by using solid-screw implants, solid-screw implants are also recommended to minimize potential biologic risk. Whereas the solid screw is accessible for peri-implant infection therapy, once the perforations are reached in the hollow-body (hollow-screw and hollow-cylinder) implants, the internal aspect of the implant may also become involved and hence may be inaccessible for therapy.[3] Thus, the standard solid-screw implant (4.1 mm) has fewer potential risks for complications during long-term function by minimizing both mechanical and biologic risk.

Problems associated with the conical cemented-abutment restorations were minimal and seen in only 2 patients. In one patient, 3 abutments loosened in the first study, and in 1 patient in the second study, 1 abutment loosened (maxillary left first premolar). The first clinician had admitted not tightening the 3 abutments to the manufacturer's recommended torque at the time of placement. No further loosening was observed in this patient after correct torque was applied in seating the abutments. These data, which include 135 posterior (75 molar and 60 premolar) teeth, compare favorably to the Becker and Becker study[7] of a 38% incidence of loosening in 21 molar implants (average 24 months of loading). However, the 43% loosening seen in the Ekfeldt et al study[8] implants (only 1 molar implant was included) and 26% in the Jemt et al study[9] of 107 implants (only 5 molars were included in the original data, with only 3 at the 3-year report[4]) are difficult to compare because of the lack of molar teeth present in their studies. It is possible that more occlusal screw loosening would have been observed in these latter 2 studies if in fact more molar teeth had been included in the original data. The fact that only 1 screw-retained crown became loose more than once (maxillary right lateral incisor, screw-retained crown) suggests that the tightening force applied to the occlusal screws is adequate. However, it is recommended that it be rechecked after the restoration is in function and loaded. It appears that titanium is an appropriate material for occlusal screws and can accept appropriate torque application for maximal tightening.

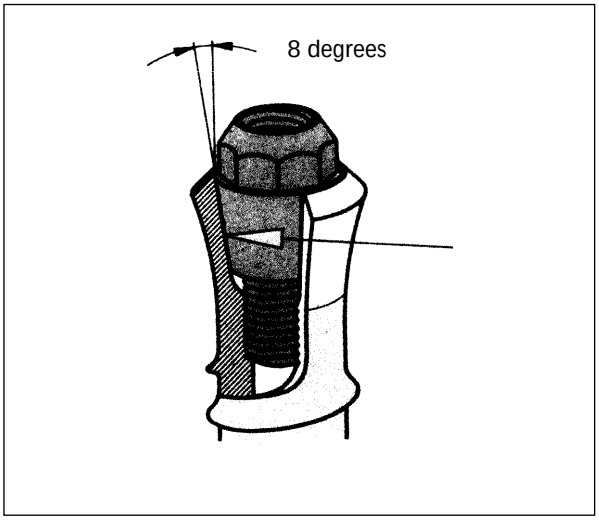

Fig 3 Eight-degree taper of the conical walls of the abutment mate with the 8-degree tapered internal walls of the implant. Such a union forms a nonrotating friction fit. Reprinted with permission from Sutter et al.[11]

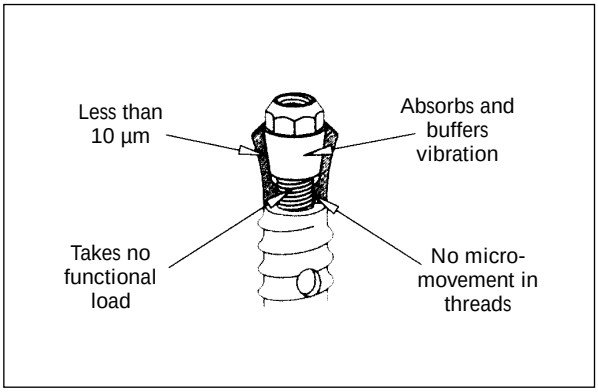

Fig 4 With a gap of less than 10 µm between parts, the friction locking of the abutment to the implant eliminates vibration and, hence, micromovement of the apical screw threads and removes the screw from functional loading. Reprinted with permission from Sutter et al.[11]

In the study one octabutment loosened in the left mandibular molar area, with a history of the crown-retaining screw being loose for approximately 3 months before the abutment loosened. The crown was salvaged, the octabutment was retightened, and the crown was reseated, with no subsequent problems. The low incidence of octabutment loosening, as well as abutment-post loosening, in this study may be a combination of implant design (8-degree Morse taper[10]) (Figs 3 and 4) and torque applied to the abutment (35 Ncm).

Conclusions

Based on the study results, the following conclusions may be drawn:

1. Minimal restorative problems are seen with either screw-retained or cemented restorations using the conical abutment. However, the most user-friendly restoration was the cemented crown on a conical abutment.
2. The use of solid-body, 4.1-mm-diameter implants is recommended whenever possible.
3. The ITI implant may be a satisfactory choice for posterior single-tooth restorations in nonbruxers, even when multiple single-tooth implants are restored within the same sextant, without the need to tripod multiple implants via splinting,[11] as noted by other researchers. This was a clinical observation by several clinicians in the present study, but further studies are needed.

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