Implant/Tooth–Connected Restorations Utilizing Screw-Fixed Attachments: A Survey of 3,096 Sites in Function for 3 to 14 Years

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Numerous problems have been reported following various therapies used to attach natural teeth to implants beneath a fixed prosthesis. This study documents the results of 843 consecutive patients treated with 1,206 natural tooth/implant–supported prostheses utilizing 3,096 screw-fixed attachments. After 3 to 14 years in function, only 9 intrusion problems were noted. All problems were associated with fractured or lost screws. This report demonstrates the efficacy of such a treatment approach when a natural tooth/implant–supported fixed prosthesis is contemplated.
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While they were originally utilized in the edentulous mandible,[1,2] osseointegrated implants have now been employed in a variety of partially edentulous situations with a high degree of success.[3–5] However, such use in the partially dentate patient forces the conscientious clinician to consider potential pitfalls that are not present in the totally edentulous condition. One such concern is the connection of osseointegrated implants and natural teeth.[6] Opinions vary as to whether to connect implants to natural teeth, and if so, how best to accomplish the task.

Numerous authors have discussed the theoretical risks inherent in rigidly connecting an immobile osseointegrated implant to a movable natural tooth.[7–9] Cited concerns include disuse atrophy of the natural tooth and porcelain fracture resulting from flexure of the fixed prosthesis. Natural teeth have demonstrated a degree of movement up to 10 times greater, both laterally and apico-occlusally, than osseointegrated implants.[7,8] When a fixed prosthesis rigidly connects natural teeth and implants, the load is accepted by each component in proportion to its relative stiffness, increasing the chance of functional overload of the implant-bone interface.[10] This concern has led Skalak[9] to propose that a resilient element, possibly in the form of a ring, be inserted between the implant and the prosthesis to mimic the displacement of the natural tooth, thus lessening the displacement differential between the natural tooth and the implant and distributing the load applied through the prosthesis more equally to each type of abutment.

In an attempt to obviate such concerns, nonrigid, semiprecision attachments have often been utilized between an implant and a natural tooth. This approach has met with a significant incidence of intrusion of the natural-tooth portion of the restoration.[11–15] Such intrusion has also been reported with the use of copings on natural-tooth abutments beneath a 1-piece natural tooth/implant–supported prosthesis.[16] Possible etiologies of this intrusion include food and debris impaction, disuse atrophy, impaired rebound memory, and mechanical binding.

Sheets and Earthman[13,17] have presented an energy dissipation hypothesis, which explores its importance in dental implant systems. Because rigid dental implants are energy-conservative, a force applied to the implant-supported crown is transferred along the implant with little change,

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resulting in an elastic deformation and minimal absorption of mechanical energy by the implant. Forces applied to the natural tooth–supported portion of the prosthesis are transferred to the root apex as a stress wave, resulting in marked energy dissipation by the periodontal ligament. This combined elastic and inelastic deformation dissipates significant mechanical energy. As a result, the natural tooth rigidly splinted to an implant receives high levels of mechanical stress, which may cause the tooth to intrude.

When attachments are used with the IMZ implant system, a resilient element made of Delrin (Nobel Biocare USA, Elk Grove Village, IL), called the intramobile connector, is always inserted between the implant and the prosthesis. This resilient element theoretically reduces the displacement differential between the implant and the natural tooth, thus lessening the concern over the aforementioned dangers when rigidly splinting an implant and a natural tooth.[18,19] Such an approach is unique to the IMZ implant system. However, a study by Rieder and Parel[11] included 2 clinicians who utilized screw-fixed attachments and still reported intrusion of the natural-tooth portion of an implant/tooth–supported fixed prosthesis.

A study by Garcia and Oesterle[12] found tooth intrusion in 3.5% of the patient population treated with implant-supported fixed partial dentures. They stated that the intrusion phenomenon was more common when nonrigid attachments were used between the implant and natural-tooth portions of the prostheses, as compared to screw-secured attachments. While Garcia and Oesterle also stated that intrusion still occurred, albeit to a lesser extent, with screw-secured attachments, the incidence of such intrusion is not specifically reported in the data.

Screw-secured, 2-piece attachments have been utilized in an attempt to prevent such intrusion from occurring. These attachments employ either a vertical screw (the "T-block") or a horizontal screw.[6,20,21] The decision to choose one approach over the other is dependent upon 2 factors: embrasure space morphology and ease of clinical access to the screw. Limited vertical dimension of the embrasure space mandates placement of a horizontal screw so as to simplify patient plaque control as much as possible. The mesiodistal dimension of the embrasure space may also demand the use of a horizontal fixation screw incorporated into the contours of the crown itself. Whenever possible, the use of horizontal screws distal to the maxillary second premolar, or the mandibular first premolar, is avoided because of compromised operator access.

The purpose of this retrospective study was to examine the incidence of natural tooth intrusion in consecutively placed natural tooth/implant–supported prostheses utilizing screw-fixed attachments over 10 years in 2 practices.

Materials and Methods

Eight hundred forty-three consecutive patients were treated with natural tooth/implant–supported fixed prostheses and followed, as best as possible, on a regular maintenance schedule in 2 private offices. While 901 patients were treated initially, 58 patients were lost to death, relocation, or an unwillingness to return for necessary maintenance visits (scheduled every 3 months) and were excluded from the study.

All prostheses were restored using the standard IMZ protocol,[6,20] which involves intramobile connectors between the implants and the prostheses and screw-fixed attachments between the natural-tooth and implant-supported aspects of the prostheses. An example of a typical treatment plan and clinical execution, chosen because it demonstrates the various types of attachments and fixation screws that were utilized throughout the patient population of the study, is demonstrated in Figs 1 and 2. Various permutations of these attachments were utilized in different situations, including unilateral or bilateral distal implants attached to natural teeth with an attachment secured by a single screw, numerous implants in pier abutment positions attached to surrounding natural teeth with multiple screw–secured attachments, and multiple anterior implants attached to distal natural teeth with multiple screw–secured attachments. One thousand two hundred six fixed prostheses utilizing 3,096 screw-fixed attachments were placed in the 843 patients from January 1985 to October 1995. Of these attachments, 2,206 utilized vertical fixation screws and 890 employed horizontal fixation screws (Table 1).

The extent of periodontal destruction was not a factor in determining whether to include remaining natural teeth in the prosthesis. If pocket elimination could be affected so as to render plaque control possible around the teeth, they were included in the prosthesis, if desirable. As a result, teeth with varying degrees of residual attachment apparatus and mobility were utilized in combination with osseointegrated implants, as previously described by Kay.[6] All prostheses were removed at least once per year, or sooner if problems warranted. At that time, resilient elements were replaced if cracked or excessively deformed.

Fig 1a Radiograph of a patient with multiple missing teeth, showing evidence of moderate to severe loss of supporting periodontium.

Fig 1b Panoramic radiographic view after surgical intervention, including implant placement and insertion of a metal-reinforced, provisional fixed splint.

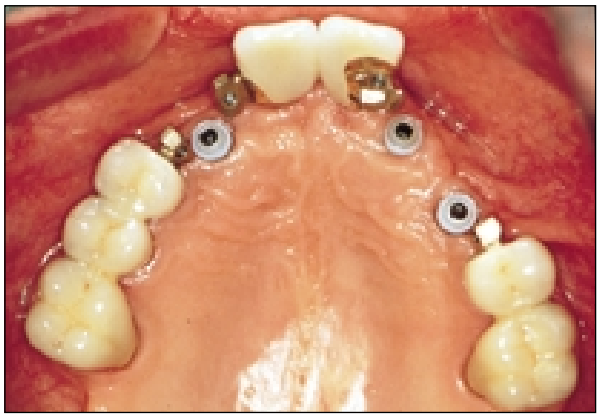

Fig 2a Natural tooth–supported portions of the splint have been permanently cemented in the mouth.

Fig 2b Clinical view of the right side of the restoration, with the implant-supported portion attached.

Table 1 Attachments Utilized and Problems Encountered

Attachment mechanism	No. of attachments	No. of intrusions	Problems associated with intrusions
Vertical screw block	2206	4	A (1), B (3)
Horizontal screw block	890	3	A (3)
Total	3096	7	A (4), B (3)

A = attachment screw fracture; B = attachment screw loss.

No prostheses placed after October 1995 were included in the study, as the authors hypothesized that the prostheses would have been functioning for too short a time to provide useful information.

Intrusion was defined as having occurred if, at any of the patient examinations, 1 or more of the following were noted:

1. An apical displacement of the occlusal aspect of the portion of the attachment incorporated into the natural-tooth restoration, when compared to the portion incorporated into the implant-supported segment of the restoration.
2. Displacement of the occlusal aspect of the natural tooth–supported portion of the prosthesis into an intra-occlusal relationship with the implant-supported portion of the prosthesis.

Results

Over the course of the study, intrusion of the natural-tooth portion of the implant/tooth–supported prosthesis occurred across 9 screw-fixed attachments (Table 1). Each of the intrusions was associated with 1 of the following clinical situations:

1. The attachment screw was lost and the patient did not return to the office at the normal interval for a maintenance visit. This occurred in 7 of the instances of intrusion. The length of time between the previous maintenance visit and the visit at which the missing screw and intrusion was noted ranged from 9 to 16 months.
2. The attachment screw fractured and the patient did not return to the office at the normal interval for a maintenance visit. This occurred in 2 of the instances of intrusion. The length of time between the previous maintenance visit and the visit at which the fractured screw or intrusion was noted ranged from 7 to 19 months.

Screw loss was noted in 11 additional patients during the scheduled maintenance visit. No intrusion was noted, and the screw was replaced during the maintenance visit. Two instances of screw fracture were also observed during scheduled maintenance visits. These fractured screws were removed and replaced during the maintenance visits.

Discussion

The survey supports the hypothesis that screw-fixed attachments, in conjunction with a resilient element interposed between the implant and the prosthesis, can prevent the intrusion of natural teeth in implant/tooth–supported fixed prostheses. While these findings would at first seem to be in opposition to the findings of Rieder and Parel,[11] further investigation demonstrates that this may not be the case. The 2 respondents to the Rieder and Parel study who reported intrusion with the use of screw-fixed attachments experienced the intrusions when the screw had fractured or been lost and the patient did not return in a timely manner for maintenance care. Neither respondent experienced natural-tooth intrusion when the screw-fixed attachment was intact. This result parallels findings of this survey.

The question does remain as to the rate of intrusion, if the screw in the attachment is fractured and/or lost. When the patients returned for the scheduled 3-month maintenance visit, no intrusion had occurred with screw loss or fracture. Even assuming that the screw loss or fracture occurred the day after the previous maintenance visit, the findings would seem to indicate that three months was an insufficient amount of time for intrusion to begin. Rieder and Parel[11] reported that intrusion occurred within the first year of restorations with movable, semiprecision attachments, which are similar to T-block attachments once the screws have been lost. Sheets and Earth-

man[13] reported intrusion after as few as 7 months of function with movable attachments. No intrusion has been reported as early as 3 months after restoration, which would be consistent with the findings reported above.

This survey does not examine the theoretical concerns of rigidly splinting implants to natural teeth without an interposed resilient element,[7–9] nor should the findings be interpreted as demonstrating that such an approach is without potential risk. All patients were restored utilizing a resilient element to reduce the displacement differential between the implants and the natural teeth in an effort to lessen the possibility of inequitable load distribution between the rigid implant and the movable natural tooth.

Conclusions

Retrospective examination of 3,096 screw-secured attachments between natural-tooth and implant-supported portions of 1,206 fixed prostheses, in function for 3 to 14 years, supports the hypothesis that such a prosthetic design can prevent intrusion of the natural-tooth portion of the prosthesis. The findings were consistent regardless of the number of teeth and implants in each case and the final prosthetic design, as long as all attachments between natural-tooth and implant portions of the prostheses were secured with intact screw-fixed attachments. No prostheses with intact screw-secured attachments demonstrated intrusion of the natural-tooth portions of the prostheses. However, if the screws in the attachments were broken or lost and were not repaired or replaced, intrusion of the natural-tooth portions of the fixed prostheses was a significant problem. The incidence and severity of the natural-tooth intrusion following screw breakage or loss would seem to be time-dependent. When such breakage or loss was discovered within 3 months of its occurrence, no natural-tooth intrusion was noted.

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