Materials and Methods

Subjects for the study were selected from a pool of patients who were missing single teeth and who preferred a treatment that precluded preparation of adjacent abutment teeth. They were either self-referred or referred from private dentists or the undergraduate dental clinic at the University of Toronto for the purpose of being considered for an implant-supported single-tooth replacement.

Thirty-three patients were selected. They comprised the entire consecutively treated group of patients in the single-tooth category study. One of them, successfully surgically treated for two single-tooth spaces, was lost to the study when she elected to have the prosthodontic treatment completed in a private practice. Therefore, this report is based on the first 32 patients on whom all phases of the treatment were completed.

There were 17 men and 15 women treated with 40 Bränemark implants (Nobelpharma AB, Gothenburg, Sweden). The patient age at the time of implant placement ranged from 16.1 to 63.2 years with a mean age of 30.8 years for the men, and from 17.0 to 63.9 years with a mean of 35.7 years for the women. Nine patients were treated with implants for 13 congenitally missing teeth, 11 patients for 12...
Osseointegration for Single-Tooth Replacement

Fig 1 Tooth locations and number of implants placed in each location (eg, 13 maxillary lateral incisors were replaced with implant-supported single tooth prostheses).

... teeth lost to caries, 10 patients for 10 teeth lost to trauma, and 3 patients for 4 teeth either impacted or removed for orthodontic reasons. One patient had lost a single tooth to periodontal disease. The precise distribution of the sites and the numbers of implants in each are noted in Fig 1. On one occasion, two adjacent missing teeth were restored using two separate implant-supported crowns. These were regarded as two units.

... All of the implants were placed using a standard two-stage osseointegration procedure. When implants were to be placed into zone 1 sites, an acrylic resin template was used to assist favourable surgical alignment and position. This is the technique the authors generally used for all patients being treated with tissue-integrated prostheses in areas where there are obvious aesthetic considerations.

... Stage 2 surgery took place approximately 6 months after stage 1 surgery for all implants, and crown construction was begun 2 to 3 weeks after the implant was uncovered and fitted with an abutment. The final crowns were made on commercially produced abutments plus gold cylinders, or on the one-piece single-tooth abutment-cylinder complex (Nobelpharma).

... When the crowns were made using abutments plus gold cylinders, they were either cast in silver palladium with acrylic resin or stock tooth forms for the aesthetic portion, or they were cast in gold alloy with metal ceramic for the cosmetic veneer. Crowns that were made on the one-piece single-tooth abutment were fabricated in porcelain or metal ceramic to metal (Figs 2 and 3). They were cemented to the abutment using zinc phosphate cement.

... Whenever possible, the occlusion was designed so that a shared and reduced occlusal load resulted in both the centric occlusion position and the lateral excursion contacts. This occurred in the vast majority of patients. Infrequently, certain occlusal morphologic situations required the implant-supported restoration to carry the bulk of the load as demanded on protrusive excursions.

Patients were recalled 1 week, 6 months, and 12 months after the final restoration was placed, after which they were recalled every 12 months. At each of these recall appointments, the tooth crown analogue was removed and each implant was assessed using the criteria of success for implants for edentulous patients as described by Smith and Zarb, including the provision of aesthetic acceptability as judged by both patient and dentist:

1. The individual unattached implant is immobile when tested clinically.
Single-tooth abutments were used in both the maxillary central incisor (top left) and mandibular molar (top right) replacements. The metal ceramic crowns are designed to allow for screw access sites of different depths (left) that frequently require placement of an obturating restoration.

This patient was treated in 1985 when her left maxillary central incisor was replaced with an implanted tooth root analogue following failure of endodontic therapy. The authors believe that hers was the first osseointegrated single-tooth replacement in North America.

2. No evidence of peri-implant radiolucency is present as assessed on an undistorted radiograph.
3. The mean vertical bone loss is less than 0.2 mm annually after the first year of service.
4. No persistent pain, discomfort, or infection is attributable to the implant.
5. The implant design does not preclude placement of a crown or prosthesis with an appearance that is satisfactory to the patient and dentist.
This study comprised the entire learning phase with the osseointegration technique of patient treatment for missing single teeth.

**Results**

Thirty-two patients were treated for 40 missing single teeth. At the most recent data collection in the fall of 1992, all implants remained in function, with loaded service ranging from 1.4 years to 6.6 years (Fig 4). Each implant was judged by both investigators to be clinically asymptomatic, immobile, and radiographically free of morbidity. No complaints of discomfort or any other symptom were forthcoming from any of the patients. All of the implants were clinically judged to be osseointegrated. Maintenance requirements were minimal and consisted mainly of crown screw tightening.

**Discussion**

Whatever the reason for the existence of the single-tooth space, there is a considerable range of cosmetic and functional sequellae that may be associated with its occurrence and its treatment. These sequellae differ and may depend on the location in the mouth, the cause of the absence, and the selected treatment method.

In the anterior region, there are very obvious aesthetic implications when a tooth is absent. For most people, restoring the resulting space is a very significant priority. For the missing molar or premolar, aesthetics may not be the major or even the exclusive concern, but restoring function and eliminating drifting or tilting of the adjacent or opposing teeth is.

There are a number of prosthodontic techniques that have been developed and which are routinely prescribed to deal with the single-tooth space. They include fixed partial dentures, removable partial dentures of either the provisional or definitive variety, and the adhesive prosthesis. While convincing evidence regarding the specific treatment outcome is sparse, extensive experience of the descriptive anecdotal type suggests that there is a place for all three categories. Sensible arguments can be advanced to emphasize that all three traditional methods have distinct advantages and disadvantages. However, each method can elicit changes to ecologic conditions of the mouth that may be manifest as irreversible consequences.

The results of this study indicate that the efficacy of the osseointegration response can be expanded to include an effective form of support for single-crown replacements. Since this support, if maintained indefinitely or for very long periods of clinical service, does not appear to impact adversely on the health of the adjacent host tissues, it is tempting to suggest that a tissue-integrated single-tooth prosthesis may offer considerable ecologic advantages (Table 1).

The authors readily concede that the success criteria employed may not be the optimal, or, indeed, the final yardstick for quantifying single-tooth replacement success. However, in the context of traditional standards that underscore the objective of treating patients without causing irre-
versatile harm — primum non nocere — this technique appears to be a prudent one.

There are two levels of interest in any clinical study of the application of osseointegration to the single-tooth space: the tooth root analogue and the coronal replacement. Preliminary studies of the clinical report variety indicate excellent, if short-term, success in both respects. Given the history of development of the clinical application of the osseointegration technique in edentulous patients, no guidelines were available regarding the abutment stress-bearing potential of single implants when this study was initiated in 1985. Therefore, the actual osseointegrated area of support that is compatible with occlusal loading of different magnitude, frequency, direction, and duration is only empirically determined. The results of this study certainly endorse the application of the osseointegration technique for abutment support for a single-crown replacement. This is not surprising when seen in the context of the very favourable occlusal loading schemes prescribed and maintained for each restoration.

If the treatment objective with single-tooth partial edentulism is an aesthetically acceptable space maintenance with reliable functional implications, the osseointegration technique appears to offer considerable promise.

All of the patients reported subjective satisfaction with their aesthetic results. This was in spite of the fact that the prosthodontic component repertoire available to us was restricted. Furthermore, the surgical learning curve in this study led to some unusual implant locations. Both patients’ and dentists’ objective assessments are currently being quantified for publication.

Recent developments related to improvement of the host bone site morphology were not prescribed for any of the reported patients. For example, bony deficits at selected implant sites can today be treated with localized grafting or osteopromotive techniques that can dramatically enhance optimal aesthetic results. Since the authors addressed the patients’ treatment needs in the somewhat narrow and exclusive context of implant anchorage and loading, a number of clinical challenges were encountered that were resolved exclusively by clinical ingenuity and reliance on available prosthetic components. The results of these improvisations will appear as a separate paper.

The tissue-integrated prosthesis technique provides dentistry with another means of replacing the missing single tooth. Within the limits of the design of this study, this method appears to come without the unfavourable consequences that may accompany the fixed partial denture, the removable partial denture, or the adhesive prosthesis.

**Conclusion**

In this clinical study on the authors’ entire first group of consecutive patients who selected implant-supported single-tooth replacements, it was observed that where the anatomy permits and where there is careful patient selection, careful surgery, and thoughtful treatment planning, the single implant can be an innocuous and problem-free treatment option with gratifying results for both patient and dentist. While the results of this study are limited in number and in duration, they appear to offer a viable alternative to traditional prosthesis prescription.

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**References**

Baseplate Wax, Dimensional Stability, and Sorption of Active Components Following Treatment With Disinfectant Solutions

If baseplate wax is to be disinfected, the influence of disinfectant solutions on the dimensional stability of the wax and the potential for active components of the disinfectants to be absorbed on the wax surface should be evaluated. The aims of this study were to evaluate the dimensional stability of a frequently used baseplate wax following treatment with various disinfectant solutions and to test whether active components of the disinfectants can attain an intimate contact with the wax surface. The influence of seven disinfectants and two methods of treatment, immersion and spray, on the dimensional stability of a baseplate wax was tested. The results showed that none of the seven disinfectants influenced the dimensional stability of the wax after spraying and four out of seven disinfectants did not influence the dimensional stability of the wax after immersion for 1 hour. The absorption/adsorption properties of the wax toward the seven disinfectants were also studied. The wax specimens did not show any significant weight increase after immersion for 4 days, but in four disinfectant solutions the surface properties of the wax specimens had changed, indicating that active components of the disinfectants were absorbed into or adsorbed on the wax surface. This finding indicates that the disinfectants have a potential for active influence on microorganisms contaminating the surface.