Changes in the Outcome of Metal-Ceramic Tooth-Supported Single Crowns and FDPs Following the Introduction of Osseointegrated Implant Dentistry into a Prosthodontic Practice

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Purpose: The aim of this study was to prospectively analyze the effect that the incorporation of osseointegrated implant dentistry had on the outcome of metal-ceramic tooth-supported prostheses that had been in situ for 5 to 10 years. ***Materials and Methods:*** The 10-year estimated (Kaplan-Meier) cumulative survival of metal-ceramic tooth-supported single crowns (TSCs) and metal-ceramic tooth-supported fixed dental prostheses (TFDPs) provided for all patients treated at two time periods was determined and statistically compared (log-rank test). Prostheses in group 1 (404 TSCs and 433 TFDP abutments in 189 TFDPs) were cemented between January 1989 and December 1993, with the outcome determined in 1998. Prostheses in group 2 (539 TSCs and 354 TFDP abutments in 142 TFDPs) were cemented between January 1997 and December 2001, with the outcome determined in 2006. A 500% increase in implants restored occurred between the end of group 1 and group 2 time periods. ***Results:*** For TSCs, comparison between groups showed a significantly better survival in group 2 than in group 1 for nonvital TSCs ($P = .001$), nonvital maxillary anterior teeth ($P = .003$), nonvital maxillary lateral incisors ($P = .008$), and nonvital premolars ($P = .013$). Comparison within groups showed nonvital TSCs had a significantly decreased survival compared to vital TSCs in group 1 ($P < .001$), but not in group 2 ($P = .48$). Overall, the estimated cumulative 10-year survival of TSCs in group 2 was 94% ± 3%. For TFDPs, comparison between groups showed a significantly better survival for nonvital abutments in group 2 than in group 1 ($P = .049$). Comparison within groups showed nonvital TFDP abutments had a significantly decreased survival compared to vital TFDP abutments in group 1 ($P = .001$), but not in group 2 ($P = .377$). Overall, group 2's estimated cumulative 10-year survival for all TFDPs was 90% ± 6% and for three-unit TFDPs was 97% ± 2%. Teeth in group 2 failed less through fracture and periodontal disease than those in group 1. ***Conclusions:*** The incorporation of osseointegrated implant dentistry has resulted in a significant improvement in the survival of TSCs and TFDP abutments, nonvital and vital teeth having equivalent survivals for TSCs and TFDPs, and a decrease in supporting-tooth failure through fracture and periodontal disease. *Int J Prosthodont 2009;22:260–267.*

Traditional paradigms concerning natural teeth have been challenged following the introduction of osseointegrated implants supporting and/or retaining prostheses. Heroic efforts to salvage teeth are no longer considered appropriate. Biologically and structurally compromised teeth are now being extracted and replaced with implants. But has the enthusiasm for implant-related dentistry gone too far? Are relatively sound teeth being ignored or even sacrificed in the rush to replace the old with the new? Are appropriate tooth-supported prostheses still viable treatment options?

Clinicians rely on published outcome data of various treatment modalities when assessing the best treatment options for their patients. The long-term survival of tooth-supported fixed dental prostheses (TFDPs)[1–4] and tooth-supported single crowns (TSCs)[5] has been well-documented. Meta-analysis indicates a 75%

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survival of TFDPs at 15 years.[1,2] However, in a recent systematic review[3] that included those studies evaluated in previous reviews, Tan et al acknowledged that only 11.6% of conventional TFDPs were metal-ceramic in design and that this accounted for the relatively high technical complication and failure rates associated with the acrylic/gold combinations. In one included study, 38% of TFDPs with acrylic resin facings were replaced, compared to only 4% of those with metal-ceramic compositions. It was observed that this distribution of TFDP types reflects that there are few studies with long-term follow-up of recent TFDP designs. Thus, the true survival rate of metal-ceramic TFDPs is possibly much higher than that currently accepted. Comparisons with TFDPs of different and recently introduced compositions, such as all-ceramic, or with alternative treatment modalities could be misleading.

Two recent meta-analytic reviews of single tooth replacement compared single implant-supported crowns (ISCs) to conventional TFDPs. Comparisons were made between ISCs and TFDPs with any number of pontics, as well as those of gold-acrylic and bonded constructions.[6,7] The validity of these reviews is questionable. Also, many of the implant studies included lacked information on the outcome of the prostheses.

The power of systematic reviews in influencing treatment-planning decisions is high. Both the profession and other third-party stakeholders may derive inappropriate conclusions from a misunderstanding of these reviews.

The high survival rate of implants is heavily promoted, but the relatively high complication rate of implant-supported dental prostheses (IDPs), for both fixed (IFDPs) and removable dental prostheses (IRDPs), is often ignored.[6,8,9] Providing the best treatment options for patients depends in part on knowledge of the comparative outcomes of the various treatment modalities considered.

A previous paper by the author[10] described the effect that the incorporation of osseointegrated implant dentistry had on the type and incidence of tooth-supported prostheses provided in a prosthodontic practice. It was found that there was a decrease in the use of teeth, both vital and nonvital, for TFDPs, as well as those teeth subjectively deemed to have an unfavorable 10-year prognosis. In addition, TFDPs with four or more pontics and those not satisfying Ante's Law have also decreased in number. It is hypothesized that these factors would similarly affect the outcome of metal-ceramic tooth-supported prostheses.

The aim of this study was to prospectively analyze the effect that the incorporation of osseointegrated implant dentistry had on the outcome of metal-ceramic fixed tooth-supported prostheses that had been in situ for 5 to 10 years.

Materials and Methods

All patients who had received metal-ceramic TSCs and TFDPs since 1989 were recruited for this long-term outcome analysis. Patients were reviewed regularly and the outcome of prostheses in two cohorts was determined for the purposes of this study. Prostheses in group 1 were cemented between January 1989 and December 1993, with the outcome determined in 1998. (Only 77 implants had been restored in the practice prior to or during this time period.) Prostheses in group 2 were cemented between January 1997 and December 2001, with the outcome determined in 2006. (By the end of this time period, 386 implants had been restored in the practice.) All prostheses in both groups had been in situ for 5 to 10 years.

Group 1 involved 140 patients receiving TSCs (64% female, 36% male; age range: 14 to 73 years; female mean = 45.8 ± 10.1 years, male mean = 46.2 ± 13.6 years) and 129 patients receiving TFDPs (60% female, 40% male; age range: 21 to 73 years; female mean = 49.7 ± 12.5 years, male mean = 51.5 ± 10.3 years). Of these 269 patients, 15% were lost to follow-up, involving 33 TSCs and 27 TFDPs.

The metal-ceramic prostheses in group 1 comprised 404 TSCs (152 on nonvital teeth) and 433 TFDP abutments (135 on nonvital teeth) in 189 TFDPs. Of the nonvital teeth, 51% had cast posts and cores. Eighty-nine teeth had been judged to have an unfavorable 10-year prognosis at cementation: 30 were TSCs and of these, 70% had unfavorable tooth integrity while 30% had unfavorable periodontal support; 59 were TFDP abutments and of these, 36% had unfavorable tooth integrity while 64% had unfavorable periodontal support. Of the teeth with unfavorable integrity, 93% were nonvital; of the teeth with unfavorable periodontal support, 47% were nonvital.

Group 2 involved 180 patients receiving TSCs (70% female, 30% male; age range: 17 to 81 years; female mean = 49.2 ± 12.0 years, male mean = 52.9 ± 13.6 years) and 104 patients receiving TFDPs (61.7% females, 38.3% males; age range: 25 to 78 years; female mean = 53.8 ± 10.4 years, male mean = 57.9 ± 9.1 years). Of these 284 patients, 11% were lost to follow-up, involving 36 TSCs and 16 TFPDs.

The metal-ceramic prostheses in group 2 comprised 539 TSCs (221 on nonvital teeth) and 354 TFDP abutments (126 on nonvital teeth) in 142 TFDPs. Of the nonvital teeth, 43% had cast posts and cores. Seventy-seven teeth had been judged to have an unfavorable 10-year prognosis at cementation: 19 were TSCs and of these, 84% had unfavorable tooth integrity while 16% had unfavorable periodontal support; 58 were TFDP abutments and of these, 57% had unfavorable tooth integrity while 43% had unfavorable periodontal support.

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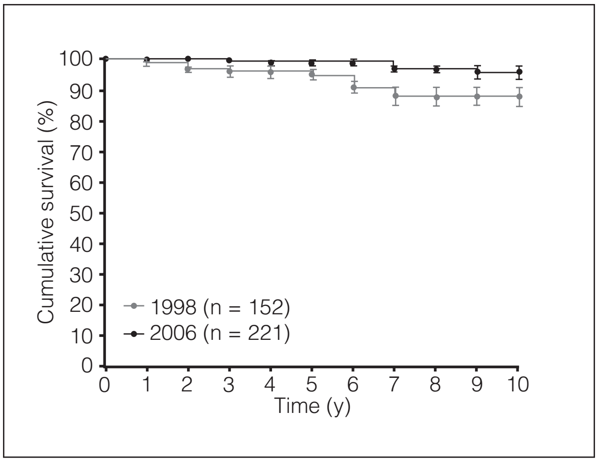

Fig 1 Kaplan-Meier 10-year cumulative survival of nonvital TSCs in group 1 (88% ± 3%) versus group 2 (96% ± 2%).

Of the teeth with unfavorable integrity, 90% were nonvital; of the teeth with unfavorable periodontal support, 36% were nonvital.

Clinical procedures for the metal-ceramic tooth-supported prostheses have been standardized and are described elsewhere.[11] One laboratory was used for the fabrication of all prostheses. All TSC and TFDP abutment impressions were copper plated, their dies trimmed, margins delineated, and models mounted by the author on arcon articulators with average value settings. All prostheses were cemented with zinc phosphate cement.

All prostheses were classified as successful, surviving, repaired, failed, or lost to follow-up (no communication with patients or they had died). The specific assessment criteria for these categories accounting for all prostheses were previously described.[11]

Records were scrutinized for evidence of any retreatment other than that previously classified as maintenance procedures. Patients who could not attend for examination were questioned as to the status of their prostheses and if possible, referring clinicians were questioned as to prosthesis status and any associated retreatment. Only those directly examined by the author were classified as successful. Those not directly examined but which remained in situ without any evidence of retreatment were classified as surviving (8% in group 1 and 17% in group 2).

Modes of failure and complications requiring follow-up treatment were tabulated. A complication was deemed to be minor when any required treatment could be undertaken within a 30-minute appointment. Any treatment requiring more time or referral to another speciality was considered to be major. Any complication involving modification of the tooth/restoration margin (ie, caries) was considered a failure, even when the complication was treated without removal of the prosthesis.

Statistical Analysis

The data were analyzed using the Kaplan-Meier estimated cumulative survival method. Surviving prostheses were those assessed in the six-field categorization as successful, surviving, and repaired. In addition, those prostheses categorized as failures but still in situ were included as surviving prostheses in the cumulative survival analysis. The clinical service time of those patients lost to follow-up was calculated from the date of cementation until the last direct examination. Cumulative survival was reported as percentage ± standard error. The standard error of the estimated cumulative survival was calculated using Greenwood's Formula. Differences between the two groups were assessed with the log-rank test. Statistical difference was set at $P < .05$. A trend was subjectively set at $P < .15$.

Results

Tooth-Supported Single Crowns

There was no significant difference in the estimated 10-year cumulative survival of group 1 (94% ± 1%) and group 2 (93% ± 3%) when all TSCs were compared ($P = .069$, chi-square = 3.298).

Comparison between groups showed no significant difference in survival of vital TSCs between group 1 (98% ± 1%) and group 2 (89% ± 8%). However, a significantly better survival for nonvital TSCs in group 2 (96% ± 2%) was noted when compared to group 1 (88% ± 3%) ($P = .001$, chi-square = 10.564) (Fig 1).

Further analysis showed that nonvital crowned maxillary anterior teeth ($P = .003$, chi-square = 9.002), nonvital crowned maxillary lateral incisors ($P = .008$, chi-square = 7.016), and nonvital crowned premolars ($P = .013$, chi-square = 6.203) had significantly better survival in group 2 compared to group 1 (Table 1). A comparison of crowned nonvital maxillary central incisors indicated no significant differences, but there was a trend for improved survival in group 2 compared to group 1 ($P = .144$, chi-square = 2.130) (Table 2).

Comparison within groups showed nonvital TSCs in group 1 had a significantly decreased survival than vital TSCs in group 1 ($P < .001$, chi-square = 24.108) (Fig 2a), but survival of nonvital and vital TSCs in group 2 were statistically similar ($P = .480$, chi-square = 0.499) (Fig 2b).

The estimated cumulative 10-year survival for combined vital and nonvital TSCs for group 2 was 94% ± 3%.

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Table 1 Teeth Supporting TSCs or TFDPs with a Statistically Significant Increase in Survival in Group 2 Compared to Group 1*

Teeth	Chi-square	*P*
TSCs		
Nonvital	10.564	.001
Nonvital anteriors	9.002	.003
Nonvital maxillary laterals	7.016	.008
Nonvital premolars	6.203	.013
TFDPs		
Nonvital	3.821	.049

*$P < .05$, log-rank test.

Table 2 Teeth Supporting TSCs or TFDPs with a Strong Trend to Increase in Survival in Group 2 Compared to Group 1*

Teeth	Chi-square	*P*
TSCs		
Nonvital maxillary central incisors	2.130	.144
TFDPs		
Nonvital maxillary central incisors	3.188	.074
Nonvital premolars	2.154	.142
Vital premolars	2.600	.107
Posterior three-unit end abutment†	2.467	.116

*$.05 > P < .15$, log-rank test.
†Excludes cantilevered prostheses.

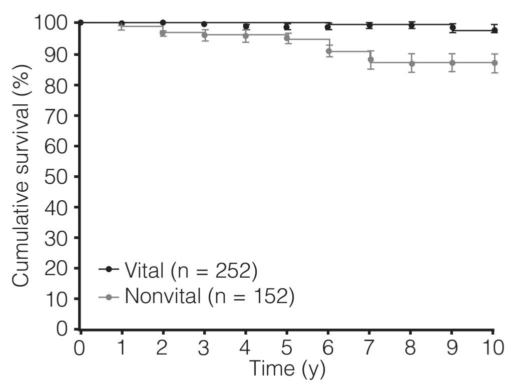

Fig 2a Kaplan-Meier 10-year cumulative survival of TSCs in group 1: vital (98% ± 1%) versus nonvital (88% ± 3%).

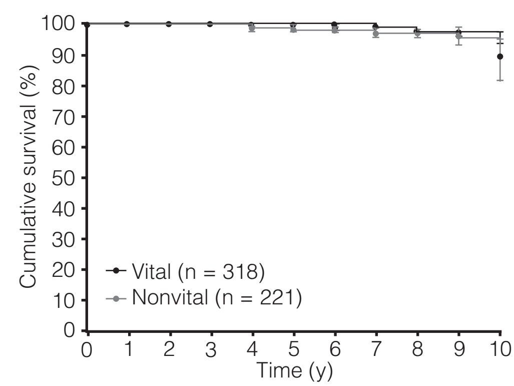

Fig 2b Kaplan-Meier cumulative 10-year survival of TSCs in group 2: vital (89% ± 8%) versus nonvital (96% ± 2%).

Tooth-Supported FDPs

There was no significant difference in the estimated 10-year cumulative survival of group 1 (77% ± 8%) and group 2 (90% ± 6%) when all TFDPs were compared ($P = .183$, chi-square = 1.775). However, further analysis showed significant differences when the individual abutments were compared.

Comparison between groups showed no significant difference in survival when all TFDP abutments for group 1 (95% ± 1%) were compared to group 2 (96% ± 1%) ($P = .414$, chi-square = 0.669) or when vital TFDP abutments in group 1 (97% ± 1%) were compared to group 2 (98% ± 1%) ($P = .781$, chi-square = 0.077). However, the survival of nonvital abutments in group 2 (96% ± 2%) had a significantly better survival than nonvital abutments in group 1 (89% ± 3%) ($P = .049$, chi-square = 3.821) (Fig 3).

There were no significant differences among specific tooth types. However, nonvital maxillary central incisors ($P = .074$, chi-square = 3.188), vital premolars

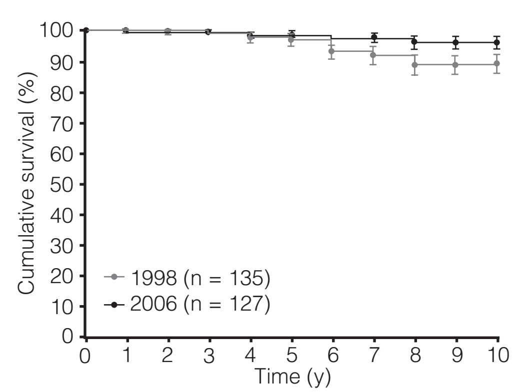

Fig 3 Kaplan-Meier 10-year cumulative survival of nonvital TFDP abutments in group 1 (89% ± 3%) versus nonvital TFDP abutments in group 2 (96% ± 2%).

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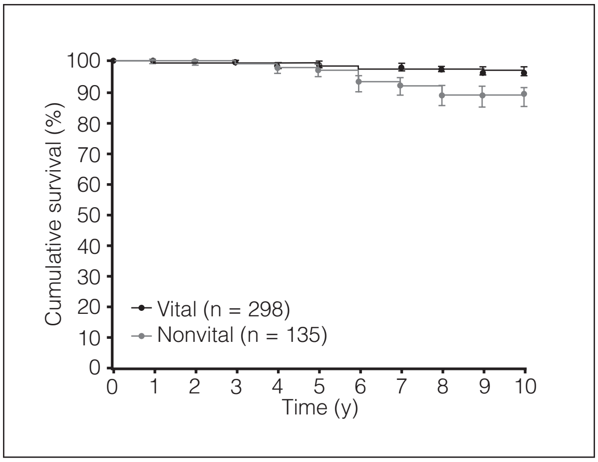

Fig 4a Kaplan-Meier 10-year cumulative survival of TFDP abutments in group 1: vital (97% ± 1%) versus nonvital (89% ± 3%).

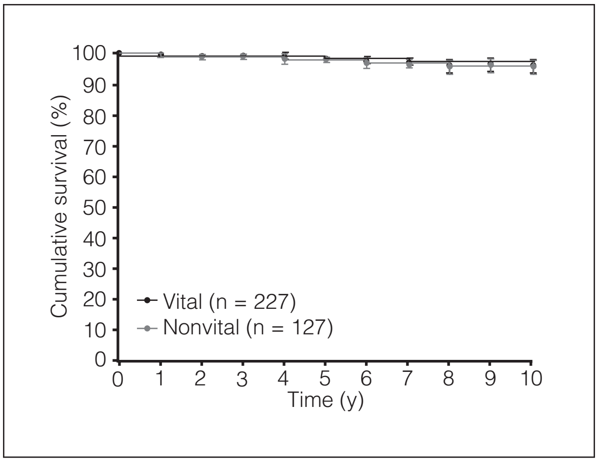

Fig 4b Kaplan-Meier 10-year cumulative survival of TFDP abutments in group 2: vital (98% ± 1%) versus nonvital (96% ± 2%).

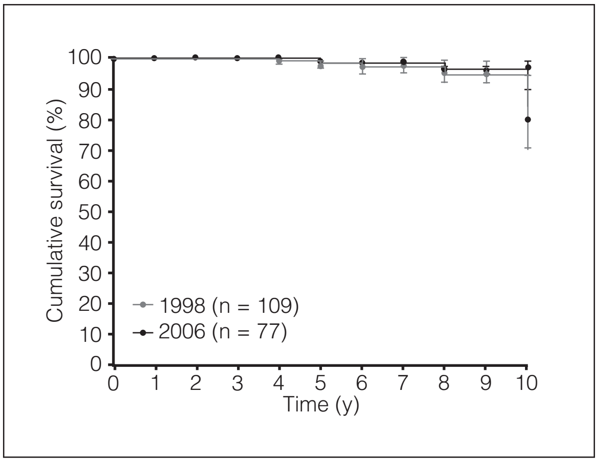

Fig 5 Kaplan-Meier 10-year cumulative survival of three-unit TFDPs in group 1 (80% ± 10%) compared to group 2 (97% ± 2%).

($P = .107$, chi-square = 2.600), and nonvital premolars ($P = .142$, chi-square = 2.154) showed a trend for improved survival in group 2 compared to group 1 (Table 2).

Comparison within groups showed nonvital TFDP abutments in group 1 had a significantly decreased survival than vital TFDP abutments ($P = .001$, chi-square = 10.387) (Fig 4a), but survival of nonvital and vital TFDP abutments in group 2 were statistically similar ($P = .377$, chi-square = 0.780) (Fig 4b).

The estimated cumulative 10-year survival for combined vital and nonvital TFDP abutments for group 2 was 97% ± 1%.

There was no significant difference in survival when three-unit TFDPs for group 1 (80% ± 10%) were compared to group 2 (97% ± 2%) ($P = .235$, chi-square = 1.409) (Fig 5). A comparison of posterior three-unit TFDPs showed a trend for an improved survival in group 2 (98 ± 2%) compared to group 1 (74 ± 13%) ($P = .116$, chi-square = 2.467) (Table 2).

Modes of Failure

Eighteen (4.5%) of 404 TSCs failed in group 1 and seven (1.3%) of 539 TSCs failed in group 2 (Table 3). These low numbers make statistical comparison difficult. However, of a total of 16 root and coronoradicular fractures, 12 occurred in group 1, representing 48% of TSC failures, while only four occurred in group 2, representing 16% of TSC failures.

Seventeen (4%) of 433 TFDP abutments failed in group 1 and eight (2.3%) of 354 TFDP abutments failed in group 2 (Table 3). Of a total of 11 root and coronoradicular fractures, seven occurred in group 1, representing 28% of TFDP abutment failures, while only four occurred in group 2, representing 16% of TFDP abutment failures. Eight (32% of TFDP abutment failures) and two abutments (8% of TFDP abutment failures) were lost through periodontal disease in group 1 and group 2, respectively.

In group 1 there were two minor and 13 major complications for TSCs and one minor and 13 major complications for TFDPs (Table 4). In group 2 there were six minor and eight major complications for TSCs and four minor and eight major complications for TFDPs. Of the 16 major complications in group 2, 71% involved loss of vitality of the supporting tooth.

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Table 3 Modes of Failure of TSCs and TFDP Abutments

	TSC failures (n = 25)*		TFDP abutment failures (n = 25)†	
	Group 1 (n = 18)	Group 2 (n = 7)	Group 1 (n = 17)	Group 2 (n = 8)
Biological				
Tooth-coronal fracture	0	3	1	1
Tooth-root fracture	12	1	6	3
Periodontal breakdown	1	1	8	2
Endodontic failure	0	2	1	0
Caries	2	0	1	2
Mechanical				
Lost retention	1	0	0	0
Lost retention (post and core)	0	0	0	0
Porcelain fracture	0	0	1	0
Metal fracture	0	0	0	0
Esthetic				
Patient determined	2	0	0	0

*25 (2.7%) out of a total 943 TSCs (group 1, n = 404; group 2, n = 539).
†25 (3.2%) out of a total 787 TFDP abutments (group 1, n = 433; group 2, n = 354).

Table 4 Complications Associated with the Prostheses From Cementation to Assessment

	TSCs		TFDPs	
	Group 1	Group 2	Group 1	Group 2
Minor				
Lost retention	1	5	1	1
Splinting and stabilization	0	1	0	1
Repaired perforations	0	0	0	2
Fractured porcelain	1	0	0	0
Total	2	6	1	4
Major				
Loss of vitality	7	6	11	6
Fractured posts	2	0	0	0
Coronoradicular fracture	3	2	2	2
RCT complication	1	0	0	0
Total	13	8	13	8

RCT = root canal therapy.

Discussion

This paper accounts for all the metal-ceramic prostheses provided (including those lost to follow-up) by a single operator in a private practice over the specified time periods. All prostheses were sequentially included at the time of cementation and prospectively followed. It has been argued that this approach to prosthodontic research is valuable—reporting clinical realities and allowing a valid scientific evaluation of risk factors for a specific clinical protocol.[12]

The prostheses' longevity and high survival testify to the effectiveness of this treatment modality (ie, the benefit deriving from the treatment provided under ordinary conditions).[13] Moreover, the effectiveness has improved significantly following the introduction of osseointegrated implant dentistry (implants restored in the practice increased by 500% between the two treatment periods assessed) and will likely further improve as awareness of and confidence in implant dentistry increases.

As previously reported,[10] TFDP span length and complexity and the use of structurally or biologically compromised teeth have decreased in this practice population since the introduction of osseointegrated implants. Given the consistency of the clinical and technical parameters, it is contended that these factors are responsible for the statistically significant improvements reported.

Previous systematic reviews on the outcome of conventional TFDPs[1–3] have noted the difficulty in comparing individual studies. Variations in clinician experience, clinical procedures, materials, and assessment criteria are the norm. Inclusion of a particular study may significantly skew results. Most reviews assessed conventional TFDPs but included outdated acrylic/gold combinations. Thus, outcome data gleaned from these systematic reviews should be used with caution, especially when comparing different treatment modalities.

In this study, the estimated cumulative 10-year survival of metal-ceramic TSCs (94% ± 3%), metal-ceramic TFDP abutments (97% ± 1%), and metal-ceramic TFDPs (90% ± 6%) for group 2 was relatively high. In addition, the complication rate was relatively low compared to that associated with alternative materials, such as all-ceramic constructions,[14] and alternative modalities, such as IFDPs.[8] Thus, it would be more appropriate if these outcomes relating to metal-ceramic tooth-supported prostheses were used in future comparisons.

It has been well documented that nonvital teeth have poorer long-term survival rates than vital teeth in TFDPs,[3,4,15–17] except for those nonvital abutments in maxillary three-unit TFDPs.[17] There are conflicting results for the relationship between vitality status and survival for TSCs.[5,18] In the present study, nonvital teeth had a significantly higher failure rate than vital teeth in group 1 for both TSCs and TFDP abutments.

However, the survival rate for both vital and nonvital TSCs and TFDP abutments in group 2 was the same. It is contended that the decrease in use of structurally compromised teeth, the majority of which were nonvital, after the introduction of implant dentistry has resulted in this outcome.

It is controversial whether the root therapy procedure or the status of the tooth results in the decreased survival of nonvital teeth. It is suggested that extensive loss of tooth structure results in less fracture resistance of the remaining dentin and in a greater use of posts in the pulp canal modified for core retention.[19] In this

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sample, the use of cast posts and cores, indicating extensive loss of tooth structure in the associated nonvital teeth, fell from 51% in group 1 to 43% in group 2.

The reduction in failures through tooth fracture (group 1: TSCs = 52%, TFDP abutments = 28%; group 2: TSCs = 16%, TFDP abutments = 16%) attests to an improvement in the structural integrity of teeth being used for tooth-supported prostheses. With the availability of implant-supported alternatives, many teeth assessed as having a poor long-term prognosis associated with compromised structural integrity have been extracted and replaced with implants.

The results of this study have significant ramifications for treatment planning decisions and paradigms maintained previously by the profession.

Those advocating extraction of root-filled nonvital teeth and replacement by implant-supported prostheses have based their considerations on what could be considered inappropriate data. Clearly, loss of vitality of a tooth per se is not indicative of poor long-term survival. It is the structural integrity of the tooth, or the integrity of the supporting tissues, that will determine survival, irrespective of tooth vitality.

A systematic review of survival of ISCs has been shown to be equivalent to survival of nonvital (endodontically treated) restored teeth.[6] Results of this study support the statement that teeth should be considered for extraction when they cannot be prepared with adequate retention and resistance form.[20] However, it has been stressed, and this study confirms, that structurally sound nonvital teeth should be considered appropriate to support either TSCs or TFDPs.

TFDP abutments with compromised periodontal support accounted for 64% of those judged to have an unfavorable prognosis in group 1, compared to 43% in group 2. Failure of TFDP abutments through periodontal breakdown was reduced (group 1 = 32%, group 2 = 8%). This attests to the changed paradigm that fewer periodontally suspect teeth should be maintained to support TFDPs following the introduction of implant dentistry. These teeth were retained previously because there was no alternative fixed prosthesis option.

However, not all periodontally compromised teeth should be extracted. In a systematic review of TFDPs supported by abutments with severely reduced, but healthy periodontal support, it was concluded that the outcome compared favorably with those TFDPs with periodontally intact abutments.[21]

The complication rates for TSCs (2.6%) and TFDPs (8.6%) for group 2 were low. The majority of the major complications involved loss of vitality of supporting teeth. In a recent systematic review, the complication rates of conventional TFDPs after a 5-year observation period was 15.7%.[22] However, the TFDPs reviewed included those with outdated gold/acrylic constructions and those that had been provided prior to the changed paradigms associated with the introduction of implant dentistry. Although the 10-year survival of the IFDPs compared favorably, 38.7% of IFDPs had complications after the 5-year observation period (compared with 15.7% associated with the TFDPs reviewed and 8.6% associated with the TFDPs in this study).

When specific teeth with TSCs were compared following the incorporation of implant-supported prostheses, nonvital maxillary lateral incisors showed a significant improvement in survival and nonvital maxillary central incisors showed a strong trend for increased survival.

Maxilllary anterior teeth are mostly subjected to nonaxial loading during contact with opposing mandibular teeth and proximal contacts are ineffective in force distribution. Thus, factors that decrease structural resistance, including root canal–treated access cavities, result in an increased risk of mechanical failure. The maxillary lateral incisors specifically have small root form, thus rendering them even more susceptible to fracture. The maxillary canines, contrarily, have robust root form and are well-structured to withstand lateral forces.

No significant differences in the survival of specific TFDP abutments between the two groups were found. However, nonvital maxillary central incisors and both vital and nonvital premolars showed a trend for improved long-term survival in group 2 compared to group 1. Intuitively, an improvement in nonvital maxillary lateral incisor TFDP abutments could be expected. However, nonvital maxillary lateral incisors are considered poor abutments and are seldom used as support for TFDPs.

Nonvital premolars are often structurally compromised. In addition, their root form and canal shape are not conducive to post placement when core retention is required. This particularly applies to two-rooted premolars. The improved survival of both vital and nonvital premolars probably also relates to their decreased use in long-span TFDPs subsequent to implant placement in the first molar region.

The estimated 10-year survival for metal-ceramic three-unit TFDPs of 97% ± 2% for group 2 was high. In a study of 134 three-unit TFDPs provided in an undergraduate clinic, there was a 20-year survival of 73%.[17] However, 90% of the prostheses were classified as posterior (canine to premolar) and 36% had nonvital abutments. In the mandible, TFDPs with vital abutments had a 96% survival rate at 20 years while those with nonvital abutments only had a 69% survival rate. The authors acknowledged that many of the post-and-core preparations of the nonvital abutments had a limited ferrule, thus indicating that these teeth were structurally compromised.

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Studies showing the 10-year survival for single ISCs are lacking. Given the results of this study, there seems little justification for treatment involving an ISC adjacent to two TSCs in the posterior regions. A three-unit TFDP would eliminate the morbidity of surgery, improve the esthetics and integrity of the abutment teeth, have a good long-term outcome, and be cost effective. This presumes that there are indications to crown these adjacent teeth and that they can be prepared with adequate retention and resistance form. Esthetic considerations in the anterior region may support an ISC with two adjacent TSCs, since implant placement may facilitate and stabilize ridge augmentation procedures.

The results of this study clearly justify the changing paradigms associated with the restoration of teeth and the replacement of missing teeth following the development of implant dentistry. Biologically and structurally compromised teeth should be considered for extraction. But, these results also provide evidence to support traditional metal-ceramic–based tooth prostheses. Indeed, the improvement in survival and the low complication rates for these prostheses emphasize the importance of adequate treatment planning. Commercially driven enthusiasm for ignoring or extracting teeth should be tempered. Considerations for different treatment options must be supported by sound evidence-based outcomes. Tooth-supported prostheses still provide viable, and at times preferred, treatment options.

Conclusions

The incorporation of osseointegrated implant dentistry into a prosthodontic practice has resulted in the following:

1. A significant increase in the survival of metal-ceramic TSCs and TFDP abutments.
2. Structurally sound nonvital and vital TSCs and TFDP abutments with statistically equivalent 10-year survival rates.
3. A decrease in failure through fracture or periodontal disease of tooth-supported prostheses.

References

1. Creugers NH, Käyser AF, van't Hof MA. A meta-analysis of durability data on conventional fixed bridges. Community Dent Oral Epidemiol 1994;22:448–452.
2. Scurria MS, Bader JD, Shugars DA. Meta-analysis of fixed partial denture survival: Prostheses and abutments. J Prosthet Dent 1998;79:459–464.
3. Tan K, Pjetursson BE, Lang NP, Chan ES. A systematic review of the survival and complication rates of fixed partial dentures (FPDs) after an observation of at least 5 years. Clin Oral Implants Res 2004;15:654–666.
4. Walton TR. An up to 15-year longitudinal study of 515 metal-ceramic FPDs: Part 1. Outcome. Int J Prosthodont 2002;15:439–445.
5. Walton TR. A 10-year longitudinal study of fixed prosthodontics: Clinical characteristics and outcome of single-unit metal-ceramic crowns. Int J Prosthodont 1999;12:519–526.
6. Torabinejad M, Anderson P, Bader J, et al. Outcomes of root canal treatment and restoration, implant-supported single crowns, fixed partial dentures, and extraction without replacement: A systematic review. J Prosthet Dent 2007;98:285–311.
7. Salinas TJ, Eckert SE. In patients requiring single-tooth replacement, what are the outcomes of implant- as compared to tooth-supported restorations. Int J Oral Maxillofac Implants 2007;22(suppl):71–95.
8. Goodacre CJ, Bernal G, Rungcharassaeng K, Kan JY. Clinical complications with implants and implant prostheses. J Prosthet Dent 2003;90:121–132.
9. Kreissl ME, Gerds T, Muche R, Heydecke G, Strub JR. Technical complications of implant-supported fixed partial dentures in partially edentulous cases after an average observation of 5 years. Clin Oral Implants Res 2007;18:720–726.
10. Walton TR. Changes in patient and FDP profiles following the introduction of osseointegrated implant dentistry in a prosthodontic practice. Int J Prosthodont 2009;22:127–135.
11. Walton TR. Ten-year longitudinal study of fixed prosthodontics: 1. Protocol and patient profile. Int J Prosthodont 1997;10:325–331.
12. Walther W. On diverse approaches to prosthodontic research: The case series approach to clinical research. Int J Prosthodont 2007;20:374–375.
13. Guckes AD, Scurria MS, Shugars DA. A conceptual framework for understanding the outcomes of implant therapy. J Prosthet Dent 1996;75:633–639.
14. Sailer I, Pjetursson BE, Zwahlen M, Hämmerle CH. A systematic review of the survival and complication rates of all-ceramic and metal-ceramic reconstructions after an observation period of at least 3 years. Part II: Fixed dental prostheses. Clin Oral Implants Res 2007;18(suppl 3):86–96.
15. Randow K, Glantz PO, Zöger B. Technical failures and some related clinical complications in extensive fixed prosthodontics. An epidemiological study of long-term quality. Acta Odontol Scand 1986;44:241–255.
16. Reuter JE, Brose MO. Failures in full crown retained dental bridges. Br Dent J 1984;157:61–63.
17. De Backer H, Van Maele G, De Moor N, Van den Berghe L. Single-tooth replacement: Is a 3-unit fixed partial denture still an option? A 20-year retrospective study. Int J Prosthodont 2006;19:567–573.
18. Valderhaug J, Jokstad A, Ambjørnsen E, Norheim PW. Assessment of the periapical and clinical status of crowned teeth over 25 years. J Dent 1997;25:97–105.
19. De Backer H, Van Maele G, Decock V, Van den Berghe L. Long-term survival of complete crowns, fixed dental prostheses, and cantilever fixed dental prostheses with posts and cores on root canal-treated teeth. Int J Prosthodont 2007;20:229–234.
20. Torabinejad M, Goodacre CJ. Endodontic or dental implant therapy: The factors affecting treatment planning. J Am Dent Assoc 2006;137:973–977.
21. Lulic M, Brägger U, Lang NP, Zwahlen M, Salvi GE. Ante's (1926) law revisited: A systematic review on survival rates and complications of fixed dental prostheses (FDPs) on severely reduced periodontal tissue support. Clin Oral Implants Res 2007;18(suppl 3):63–72.
22. Pjetursson BJ, Brägger U, Lang NP, Zwahllen M. Comparison of survival and complication rates of tooth-supported fixed dental prostheses (FDPs) and implant-supported FDPs and single crowns (SCs). Clin Oral Implants Res 2007;18(suppl 3):97–113.

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