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Periodontal response to all-ceramic crowns (IPS Empress) in general practice

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Abstract: Objective: The purpose of this study was to investigate the periodontal response to the presence of allceramic crowns (IPS Empress) in general practice patients. Methods: The convenience sample included 82 IPS Empress crowns placed in 64 patients. These crowns had been in place for an average of 16.27 (SD 9.26) months and ranged from 6.2 to 48.87 months at the time of clinical examination. Periodontal health status (as determined by dental plaque, gingival health status, periodontal pockets) was assessed around all crowned teeth and around matched contralateral teeth by one calibrated examiner. Periodontal indices utilized included the Plaque Index (PI), Gingival Index (GI) and pocket depth (PD) with calibrated probes graduated in millimetres. Plaque, gingival and PD values for crowned teeth were compared with those for control teeth using Wilcoxon signed-rank test for each clinical parameters. Chi-square was used to test the significance of the difference in their distribution between crowns and control teeth. Results: Statistically, PI (0.35), GI (0.41) and mean PD scores (1.42) of IPS Empress crowned teeth compared less favourably with scores of the control teeth (0.27, 0.23 and 0.86 respectively). Conclusion: Teeth with IPS Empress crowns had poorer periodontal health and more clinically evident plaque than uncrowned teeth.

Key words: all-ceramic crowns; general practice; gingivitis; periodontitis; plaque

Introduction

Demand for aesthetic dental restorations and public concerns about adverse systemic effects from dental metals and alloys have led to the increased use of ceramics in patient care (1, 2). Over the last decade, all-ceramic crowns have been widely placed in patients and many studies on their clinical performance have also been published (1–11). However, there are markedly fewer studies dealing with all-ceramic crowns placed by general practitioners as compared with those placed in patients at a university or specialist clinics (1, 12).

It is widely agreed the conventional glazed porcelain is the restorative material that least encourages plaque accumulation and allow plaque to be easily removed (13, 14). However, the periodontal response to the recently marketed ceramics was scarcely investigated in the literature, even though the periodontal response to restorative treatments is critical in determining the long-term success of such treatments (15, 16).

In two separate studies, Sjögren *et al.* (1, 12) concluded that with regard to the occurrence of dental plaque and bleeding on probing, no significant differences were observed between the two examined crowns (Dicor and Empress respectively) and the control surfaces. Gemalmaz and Ergin (2) found no significant difference in the gingival health status of teeth with all-ceramic crowns that had margins placed above or at the level of the gingival margin. However, in crowns that had subgingival margin finish lines, the percentage of bleeding on probing around the crowns was significantly higher than that of the contralateral controls.

For 12 months, Burke *et al.* (17) evaluated the clinical performance of dentin-bonded ceramic crowns and reported optimal gingival health (70%) at the labial aspects of the all-ceramic crowns examined, whereas 30% of the examined crowns showed inflammatory changes.

Since the introduction of Dicor, a castable ceramic material (Corning Glass Works, Corning, NY, USA) in 1984 (18) a number of all-ceramic prostheses have been developed. At present, most all-ceramic systems fall into two categories: aluminabased core materials and castable (or pressable) glass matrix ceramics (19). The IPS Empress system (Ivoclar Vivadent, Schaan, Liechtenstein) belongs to the latter category. Thus the aim of this study was to examine patients' periodontal response to IPS Empress crowns in general practices.

Materials and methods

A convenience sample of all patients (n = 126) who have had IPS Empress crowns provided at five private or public dental centres in Amman, the capital of Jordan, between 1999 and 2004 were invited to participate in a follow-up examination. For inclusion, eligible subjects had to have received one IPS Empress crown for at least 6 months and verbally consent to participate in the follow-up evaluation. The exclusion criteria were that subject received scaling within the last 6 months or suffered from other diseases known to influence the severity of periodontal disease such as Down syndrome or diabetes. All patients meeting these criteria were contacted by telephone and given details of the objective of the investigation and asked to undergo an examination of their teeth and crowns. Those who did not attend after three phone calls were excluded. From those contacted, 90 patients fulfilled the inclusion criteria and 79 agreed to an examination. Of those, 64 subjects met the inclusion criteria and were included in the final evaluation. For each crown, periodontal measurements were taken by one calibrated dentist. For each crown a respective contralateral tooth in the same arch was examined as a control. Where no control was available, the patient was excluded from the study. The following periodontal indices were used on abutment and control teeth at four sites: mesiobuccal (mesiolabial), midbuccal (midlabial), distobuccal (distolabial) and midpalatal (midlingual).

The Plaque Index (PI), a modification of Silness and Löe (20), was scored as:

0: No plaque was detected on the gingival or crown margin or the area in between.

1: Plaque was visible following probing of either gingival margin of the crown or gingival area of the tooth.

2: Plaque was visible on a portion of both the gingival and crown margins without the need to probe.

3: Plaque was visibly continuous on both the gingival or crown margins and/or calculus was visible.

The Gingival Index (GI) by Löe and Silness (21) was modified and used to evaluate the degree of gingival inflammation on crown and control teeth at the defined sites as follows:

0: Absence of inflammation.

1: Mild inflammation of the gingiva; slight change in colour, slight oedema and no bleeding.

2: Moderate inflammation of the gingiva; redness, oedema and glazed appearance and bleeding on probing.

3: Severe inflammation of the gingiva; marked redness, oedema and tendency to spontaneous bleeding.

Pocket depth (PD) was measured as described by Ramfjord (22) from the free gingival crest to the level of attachment of the periodontium at the four previously mentioned sites. All the measurements were made with calibrated probes graduated in millimetres (University of Michigan, Pattern 0 with Williams markings; Hu Friedy, Chicago, USA) under a standard dental light with patient seated in a semisupine position in a standard dental chair.

Ten subjects were randomly selected and re-examined by the same examiner to establish intra-examiner reliability. The PI, GI, PD and the location of the crown margins were re-examined and recorded before calculation. Kappa statistics values of 0.85 and 0.88 were calculated for the PI and GI respectively. No significant difference was observed between mean PD at first (2.10 mm) and second assessment (1.97 mm) (t = 0.81, P = 0.43). Kappa for the location of the margins was calculated at 0.93. Results demonstrated the examiner's intra-examiner reliability.

Statistical analysis

Excel was used to produce a clustered column graph which enabled comparison of values across crowns and control teeth. Values for plaque, gingival health status and PD for crowns were compared with those for control teeth using Wilcoxon signed-rank test. Chi-square was used to test the significance of the difference in their distribution between crowns and control teeth. All statistical analyses were performed using the Statistical Package for Social Sciences (version 11.5; SPSS Inc., Chicago, IL, USA). P < 0.05 was considered statistically significant.

Results

In the present study 79 patients of 90 attended for examination. This represents an initial response rate of 87%. Of those, 81% (n = 64) met the inclusion criteria for the final response rate. There were 27 female (42%) and 37 male patients (58%) with a mean age of 28.4 years (SD 3.6) ranging from 19 to 48 years at the examination. The examined patients had 82 crowns available for assessment. The crowns had been in place for an average of 16.3 months (SD 9.3) and ranged from 6.2 to 48.2 months at the time of examination. Sixty crowns (73%) were in the anterior region, 22 (27%) were in the posterior region. The distribution of the crowns by the type of tooth is displayed in Table 1. Fifty-two patients had one crown, four patients had four crowns, three patients had two crowns, one patient had three crowns and one patient had five crowns.

lable 1. The distribution of the crowns by type of too
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Tooth type	Number of crowns	Percentage		
Maxillary				
Incisors	40	48.8		
Canines	9	10.8		
Premolars	10	12.0		
Molars	5	6.0		
Mandibular				
Incisors	11	13.2		
Canines	0	0		
Premolars	2	2.4		
Molars	5	6.0		
Total	82	100		

Table 2 and Fig. 2 show the frequency distribution of PI, GI and PDs of the crowns and the controls.

Dental plaque

There was significantly more plaque associated with the crowns compared with control teeth (P = 0.015) (Fig. 1). None of the cases earned a scored of 3 (plaque was visibly continuous on both margins and/or calculus was visible).

Gingival Index

The average GI score was significantly higher in the crowns compared with control teeth (P < 0.0001) (Fig. 1). Higher gingival scores were more common on the distal surfaces of the crowns compared with those on control teeth (P < 0.0001) (Table 2). None of the cases earned a score of 3 (severe inflammation of the gingiva; marked redness, oedema and tendency to spontaneous bleeding).

Periodontal pocket depths

Pocket depths were generally shallow with only a small proportion of 3 mm (Table 2).

None of the depths exceeded 3 mm. The mean PD of the crowns was higher than the controls (P < 0.0001) (Fig. 1).

The relationship between periodontal indices and marginal adaptation was examined and statistically analysed (Table 3). Palatal subgingival margins and margins at the gingival level showed more plaque than on the control teeth (P = 0.025 and 0.029 respectively), whereas there was no statistically significant difference between controls and crowns with palatal/lingual supragingival margins (P = 0.317). Labially and palatally/



Fig 1. Comparison of average Plaque Index, Gingival Index and pocket depth scores related to Empress crowns (n = 82) and matched contralateral controls.

	Mesial (% surfaces)		Distal (% s	Distal (% surfaces)		ual (% surfaces)	Buccal/labial (% surfaces)		
	Crown	Control	Crown	Control	Crown	Control	Crown	Control	
Plaqu	e Index								
0	69.5	71.8	67.1	73.1	70.7	84.6	62.2	70.5	
1	28.0	24.4	31.7	25.6	23.2	15.4	37.8	28.2	
2	2.4	3.8	1.2	1.3	6.1			1.3	
	P-value = 0	0.783	P-value = (P-value = 0.698		P-value = 0.030).275	
Gingi	val Index								
0	59.8	78.2	67.1	78.2	76.8	84.6	53.7	70.5	
1	30.5	20.5	29.3	20.5	19.5	15.4	40.2	28.2	
2	9.8	1.3	3.7	1.3	3.7		6.1	1.3	
	<i>P</i> -value = 0.143		<i>P</i> -value < 0.0001		<i>P</i> -value = 0.170		<i>P</i> -value = 0.050		
Pocke	et depth								
0	2.4	34.6	2.4	35.9	3.7	35.9	2.4	32.1	
1	46.3	43.6	45.1	44.9	82.9	55.1	54.9	51.3	
2	42.7	15.4	46.3	12.8	13.4	9.0	39.0	14.1	
3	8.5	6.4	6.1	6.4			3.7	2.6	
	<i>P</i> -value < 0.0001		<i>P</i> -value < 0.0001		<i>P</i> -value < 0.0001		<i>P</i> -value < 0.0001		

Table 2. Frequency distribution of	Plaque Index, Gingiva	al Index and pocket	t depth scores related	d to mesial, distal,	palatal/lingual and
buccal surfaces of crowns ($n = 328$	3) and contralateral co	ontrols (<i>n</i> = 328)			



Fig 2. Frequency distribution of Plaque Index, Gingival Index and pocket depth scores related to surfaces of crowns and contralateral controls. 0, 1, 2 and 3 are explained in the *Materials and methods*.

lingually, only crowns with subgingival margins showed significantly more plaque and gingivitis than controls (P = 0.034 and 0.013 respectively).

There were more palatal/lingual crown PDs with all margin levels than the control teeth (at gingival level P = 0.003; supragingival P = 0.046; subgingival P = 0.001). Similar results were found with labial margins (at gingival level P = 0.02; subgingival P < 0.0001) with one exception, i.e. the supragingival margins (P = 0.059).

The labial margin was recorded as being at the level of the adjacent gingivae for 40 crowns (48.8% of the 82 crowns placed), above the gingival margin for seven crowns (8.5%) and subgingivally for 35 crowns (42.7%). The palatal/lingual margin was placed at the gingival margin for 47 crowns (57.3% of the 82 crowns placed), above the gingival margin for nine crowns (11.0%) and subgingivally for 26 crowns (31.3%).

Discussion

The periodontal response to restorative treatments is critical in determining the efficacy of such treatments and their longterm success in keeping the patient healthy. In the present study, periodontal-response comparisons were made between all-ceramic crowned teeth and control teeth within the same subjects revealing statistically significant differences in PI, GI and mean PD.

In the present study, IPS Empress crowns showed significantly more plaque than control teeth. These findings conflict with those of Sjögren et al. (1, 12) who reported no significant differences in plaque retention between teeth with Dicor or Empress crowns and control teeth. Also, Gemalamz and Ergin (2) found that plaque retention capacity of IPS Empress crowns was significantly less than that of the control teeth. Thus, the results of the present study conflict with Gemalmaz and Ergin (2), who explained that the reduced plaque retention on IPS Empress crowns may be attributed to the special interest of patients in crowns subjected to periodic evaluations. Several previous studies showed a reduction in plaque associated with all-ceramic crowns (3, 9, 23). Conflicting findings from different studies may be attributed to several factors such as variance in the time period of crowns clinical service as well as the possibility that the condition of the surfaces of the crowns may have changed with time. Furthermore, oral

	Palatal gingival margin				Labial gingival margin					
	Crowns	Crowns		Controls		Crowns		Controls		
	Mean	SD	Mean	SD	P-value	Mean	SD	Mean	SD	P-value
Average plaque score	es									
At gingival level	0.36	0.57	0.16	0.37	0.029	0.40	0.50	0.47	0.51	0.157
Supragingival	0.67	1.00	0.44	0.53	0.317	0.43	0.53	0.14	0.38	0.157
Subgingival	0.23	0.43	0.03	0.20	0.025	0.34	0.48	0.17	0.45	0.034
Average gingival sco	res									
At gingival level	0.23	0.48	0.16	0.37	0.317	0.58	0.59	0.42	0.50	0.083
Supragingival	0.78	0.83	0.44	0.53	0.083	0.43	0.79	0.14	0.38	0.157
Subgingival	0.15	0.37	0.04	0.20	0.083	0.49	0.61	0.23	0.49	0.013
Average pocket dept	h scores									
At gingival level	1.11	0.43	0.78	0.71	0.003	1.52	0.68	1.17	0.81	0.020
Supragingival	1.22	0.67	0.78	0.44	0.046	1.14	0.69	0.43	0.53	0.059
Subgingival	1.04	0.20	0.62	0.50	0.001	1.40	0.50	0.66	0.59	< 0.0001

Table 3.	Observed fre	auencies fa	or level of	crown marc	ins and place	aue index.	ainaiva	l index and	pocket der	oth
		4				q	3			~

hygiene habits can change over time when interest in the crowns decrease and this may be one reason why the differences between crowns and controls decrease with time. The fact that proximal and labial surfaces of the crowns had no statistically significant plaque difference than respective control surfaces may suggest that the patients are not using interdental aids to maintain periodontal health.

In the present study, significant differences in GI scores were found between the crowns and the controls and may be attributed to the position of margins, i.e. only 11% were supragingival palatally, 8.5% labially and the majority were subgingival or at the gingival margin (91.5% labially and 88.5% palatally respectively). Therefore, crown margins should be placed above the gingival margin when possible as subgingival crown margins might impede proper oral self-care.

Though the results of the present study conflict with those of Gemalmaz and Ergin (2) regarding plaque scores, they re-affirm their mutual findings regarding gingival health status as they reported more gingivitis associated only with the crowns with subgingival finish lines than that of the contralateral control teeth, whereas the GI scores of crowns with margins placed at or above the gingival margin were similar to those of controls. Burke *et al.* (15), in a prospective clinical evaluation on 109 dentin-bonded crowns, reported optimal gingival health in 70% and visible inflammatory changes and bleeding on probing in 29% of the sample after 1 year.

In the present study, a statistically significant difference was detected between overall probing depths of abutment and control sites. Most of the PDs at the crown sites were found to be <3 mm which indicated that in spite of the statistically significant difference between the crown sites and the controls, clinically the crowns did not induce pathological pocketing.

The periodontal response to all-ceramic crowns is a major factor in determining their efficacy and utility to both dental practitioners and their patients. In the present study, more plaque, gingivitis and PD were associated with IPS Empress crowned teeth surfaces than with matched contralateral control tooth surfaces. Deliberate patient education in oral hygiene is essential if patients are to control the higher prevalence of gingivitis and pocketing and prevent future periodontal disease progression. Dental hygienists are particularly able to devote time and expertise to this patient and dental practice need. The critical importance of daily oral health maintenance by the patient should be further reinforced by the general dental practitioner. Given that clinical signs of periodontal disease develop over a long period of time, this cohort should be evaluated annually to monitor the long-term relationship between all-ceramic crowns and periodontal disease progression.

Findings also underscore the role for dental hygienists in the practice of contemporary dentistry.

Conclusion

The results of this study provide evidence of greater plaque accumulation, higher gingivitis levels and greater mean probing depth in patients with all-ceramic crowns (IPS Empress) compared with control teeth. Thus, comprehensive and periodic assessment of the client's oral hygiene knowledge, oral hygiene skills and oral self-care behaviours are required by subjects with or receiving IPS Empress crowns.

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