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Long-term Survival of Direct and Indirect Restorations Placed for the Treatment of Advanced Tooth Wear

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Abstract - *Advanced tooth wear was restored with direct resin-based composites (RBCs) in 17 patients, and with indirect ceramo-metal crowns (CMCs) and full gold crowns in 8 other patients. The mean patient age was 64.9 (8.6 SD) years, with each patient having a mean of 13.8 (5.4) restorations. In this retrospective case series study, the mean restoration age was 5.0 (3.0) years for the direct and 5.9 (2.6) years for the indirect restorations. Over 10 years, cumulative survival estimates were 62.0% for direct and 74.5% for indirect restorations (P=0.23). Survival estimates were 58.9% for anterior RBCs and 70.3% for anterior CMCs (P=0.06). RBCs usually failed from fractures, and CMCs from complete losses. RBC failures were usually replaced or repaired, while CMC failures often required root canal therapies or extractions. The findings from this relatively small study require confirmation by large long-term controlled clinical trials.*

KEY WORDS: Tooth wear, Resin composite, Crowns

INTRODUCTION

Tooth wear or tooth surface loss is observed increasingly in both younger and older persons in modern societies[1,2]. Although the aetiology is often multifactorial, acid erosion (corrosion) is a principal cause in younger persons and also is observed frequently in older persons[3,4]. Advanced tooth wear with large areas of exposed dentine is a restorative problem for older patients who want to retain their remaining teeth. Traditional restorative treatments for these patients usually involve costly laboratory-fabricated multiple crowns and fixed prostheses as a 'full-mouth reconstruction'.

However, the concept of the 'shortened dental arch'[5,6], the often localized sites of tooth wear, the ability of non-occluding permanent teeth to continue to erupt[7-9] (following an increase in occlusal vertical dimension), and the continued improvements in resin-based composites (RBCs) and adhesives have resulted in more conservative restorative treatment approaches. The potential advantages of using direct tooth-coloured restorative materials include the preservation of sound tooth substance, less overall clinical time and costs, an acceptable appearance and high patient acceptance[8-11].

Reports on the use of direct placement RBCs for the treatment of tooth wear have been largely confined to the treatment of localized anterior tooth wear[9,12-15]. The few clinical studies that have been published on the results of using RBCs to treat localized anterior tooth wear, have reported encouraging results over periods of up to approximately 5 years[9,14]. There have been very few reports on the treatment of localized posterior tooth wear and generalized tooth wear with RBCs[10,11], and the authors were unable to locate any English language publications of controlled clinical trials. The authors were also unable to locate any studies which compared the long-term clinical behaviour of RBCs with that of conventional indirect single crowns used to treat advanced tooth wear in older persons.

The objective of the present retrospective case series study was to investigate the long-term survivals of single direct and indirect restorations placed in two separate groups of older patients for the restoration of advanced tooth wear. The null hypothesis proposed is that there are no significant long-term restoration survival differences between the two groups of patients.

MATERIALS AND METHODS

In 2004, an independent reviewer (RJS) examined the dental records of patients who had been treated for advanced tooth wear (as shown by large areas of exposed dentine) by two prosthodontists at the Adelaide Dental Hospital, Adelaide, South Australia. Records were found for 17 patients where only direct restorations were placed following a treatment policy change, and for 8 patients (controls) where only indirect restorations were placed as was the previous practice. The direct placement restorative materials were fine-particle hybrid RBCs. The indirect placement restorative materials were low-gold content casting alloys and sintered porcelains. The University of Adelaide Committee on the Ethics of Human Experimentation approved the study.

Data collected from the dental records included: ages of patients and restorations; principal reasons for seeking dental treatment and the probable aetiology of the tooth wear; numbers of opposing tooth contacts and restored tooth types, restoration classes, removable partial dentures made; restoration failures and subsequent treatments. Restorations were deemed to have failed when either the restorations or the restored teeth required further operative treatments.

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All data were encoded for confidentiality in a database before being analyzed using a statistical software package (Prism 2.01; GraphPad Inc., San Diego, CA, USA). Descriptive statistics were analyzed using Student's unpaired t-test and Chi-square or Fisher's exact tests, while restoration survival estimates were analyzed using the Kaplan-Meier method. The probability level was set at α=0.05 for statistical significance.

RESULTS

The 25 patients had a mean age of 64.9 (8.6 Standard Deviation) years at the time of the initial treatments, ranging from 43 to 80 years. All had advanced tooth wear with large areas of exposed dentine, and sought dental treatment principally because of concerns about combinations of continued wear (17 instances), poor appearance (6), tooth sensitivity (5) and inadequate chewing ability (5). The principal reasons for the tooth wear or tooth surface loss were thought to be combinations of tooth grinding (21 instances), gastric and dietary acids (11) and abrasive restorative materials (2).

The distribution of the number of patients by the two types of restoration for patient ages, opposing tooth contacts and restored teeth is shown in Table 1. There were no statistically significant differences between the two restoration groups for any of these factors (P>0.10). The mean number of restorations placed in each patient was 13.8 (5.4), with a median of 14 restorations. Fourteen patients had 20 removable partial dentures made as part of their treatments, without statistical significance between the two restoration groups (Fisher exact test =0.24).

The distribution of the number of restorative materials by teeth and classes is shown in Table 2. There were significantly more RBC restorations placed in the anterior teeth, and full gold crown (FGC) restorations in the posterior teeth. There were proportionally more anterior than posterior RBC and ceramo-metal (CMC) restorations placed. RBC was placed principally to restore Class IV/incisal preparations. The mean age of the direct restorations was 5.0 (3.0) years, and that of the indirect restorations 5.9 (2.6) years, which was statistically significant (t=2.884, df=362, P=0.004).

The distribution of the number of restorative materials by their principal failure modes and subsequent treatments is shown in Table 3. Overall failures were; FGCs 3.6%, RBCs 22.8% (20.8% anteriors, 2.0% posteriors), and CMCs 25.2% (13.9% anteriors, 11.3% posteriors). There were significantly more anterior than posterior failures for the RBC restorations (P=0.03), but not for the CMC restorations (P=0.17). There were relatively more fractured RBCs and more lost or dislodged CMCs. This resulted in significantly more RBC replacements and repairs, and more CMC root canal therapies or extractions and crown recementations (P<0.0001). In some instances, several treatments were undertaken for individual restoration failures.

Cumulative survival estimates for all of the direct and indirect restorations are shown in Table 4 and illustrated in Fig 1. Although a trend was present which favoured the indirect restorations, there was no significant survival difference between the two types of restorations over periods of up to 10 years (Logrank test: χ^2 =1.414, df=1, P=0.23). At 10 years, 62.0% of the direct and 74.5% of the indirect

Table 1. *Number (N) of patients by restoration types; for ages, opposing tooth contacts and restored teeth*

Restoration type (N)	*Patient ages (yrs)*	*Opposing contacts*			*Restored teeth*		
		A	*P*	*M*	*A*	*P*	*M*
Direct (17)	65.9 (1.8)*	10.8 (1.7)	3.6 (2.7)	2.5 (2.8)	9.3 (3.4)	2.4 (1.7)	1.4 (2.2)
Indirect (8)	62.8 (3.8)	11.4 (0.9)	4.5 (2.9)	3.6 (4.0)	11.4 (2.7)	4.0 (2.3)	2.1 (2.3)
t-test, df=23	0.821	0.938	0.724	0.837	1.621	0.664	0.806
P value	0.42	0.36	0.45	0.41	0.12	0.51	0.43

A = Anterior, P = Premolar, M = Molar. *Mean (Standard Deviation).

Table 2. *Number of restorative materials by teeth and classes*

Material (N)	*Teeth*			*Classes*		
	A	*P*	*M*	*I/II*	*IV*	*Cr*
RBC (202)	164	33	5	35	125	42
CMC (115)	77	26	12	0	0	115
FGC (28)	0	18	10	0	0	28
Total (345)		241			35	
		77			125	
		27			185	
χ^2		85.0, df=6			211.2, df=4	
P value		<0.0001*			<0.0001*	

A = Anterior, P = Premolar, M = Molar. Cr = Crown.
RBC = Resin-Based Composite, CMC = Ceramo-Metal Crown,
FGC = Full Gold Crown. *Statistically significant.

Table 3. *Number of restorative materials by principal failure modes and their treatments*

Material (N)	*Tooth failure*		*Restoration failure*			*Tooth treated*		*Restoration treated*		
	Fract.	*Pulp*	*Fract.*	*Lost*	*Caries*	*RCT*	*Extr.*	*Repl.*	*Rep.*	*Rec.*
RBC (46)†	1	2	27	14	2	2	0	22	24	
CMC (29)‡	1	4	7	13	4	9	7	5	6	9
FGC (1)					1	1		1		
Total (76)	2	6	34	27	7	12	7	28	30	9
	χ^2=10.690, df=6, P=0.10					χ^2=40.170, df=6, P<0.0001*				

Fract. = Fractured, RCT = Root Canal Therapy, Extr. = Extracted, Repl. = Replaced, Rep. = Repaired, Rec. = Recemented. †Anteriors = 42, Posteriors = 4. ‡Anteriors = 16, Posteriors = 13. *Statistically significant.

Table 4 . *Survival estimates for all direct and indirect restorations*

Period (yrs)	*Numbers at risk*		*Cumulative survivals (SE)%*	
	Direct	*Indirect*	*Direct*	*Indirect*
0-1	202	143	94.6 (1.6)	93.7 (2.0)
1-2	191	134	90.6 (2.1)	91.6 (2.3)
2-3	167	131	89.5 (2.2)	90.9 (2.4)
3-4	119	130	81.2 (3.1)	87.4 (2.8)
4-5	77	87	80.2 (3.2)	80.4 (3.6)
5-6	60	67	70.8 (4.4)	78.0 (3.9)
6-7	49	56	67.9 (4.6)	76.6 (4.1)
7-8	46	37	65.0 (4.9)	74.5 (4.4)
8-9	44	37	62.0 (5.1)	74.5 (4.4)
9-10	42	26	62.0 (5.1)	74.5 (4.4)

SE = Standard Error. Logrank test: χ^2=1.414, df=1, P=0.23 (Not statistically significant)

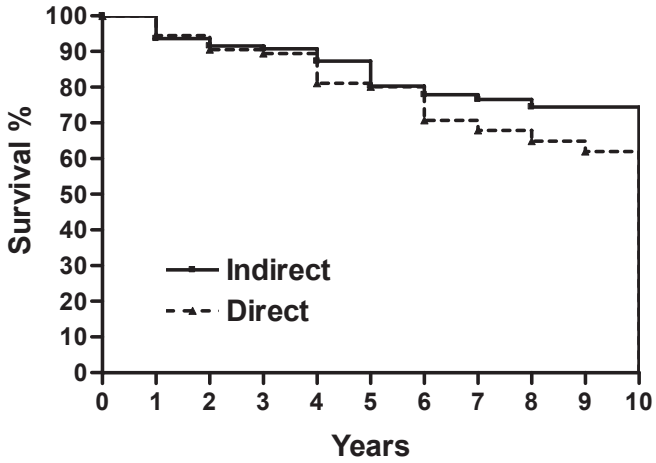

Figure 1. *Cumulative survival estimates for all the direct and indirect restorations over 10 years.*

restorations remained satisfactory. Cumulative survival estimates for the anterior direct RBC and anterior indirect CMC restorations only are shown in Table 5 and illustrated in Fig 2. Although there was a strong trend for lower RBC survivals, the survival difference between the anterior RBC and CMC restorations was marginally significant over periods of up to 10 years (Logrank test: χ^2=3.570, df=1, P=0.06). At 10 years, 58.9% of the RBC and 70.3% of the CMC restorations remained satisfactory. Therefore, the null hypothesis was not rejected.

DISCUSSION

The numbers of opposing tooth contacts and restored teeth were very similar in the two groups of patients comprising direct and indirect restorations (Table 1). Both groups of patients had higher numbers of opposing anterior tooth contacts than posterior tooth contacts, because of many posterior tooth extractions, which resulted in 14 patients having 20 removable partial dentures fabricated as part of their treatments.

Table 5. *Survival estimates for anterior direct RBC and indirect CMC restorations*

Period (yrs)	*Numbers at risk*		*Cumulative survivals (SE)%*	
	Direct RBC	*Indirect CMC*	*Direct RBC*	*Indirect CMC*
0-1	164	77	93.3 (2.0)	96.1 (2.2)
1-2	153	77	90.24(2.3)	96.1 (2.2)
2-3	133	74	88.9 (2.5)	94.8 (2.5)
3-4	100	73	79.1 (3.5)	90.9 (3.3)
4-5	64	52	77.9 (3.7)	83.9 (4.5)
5-6	51	40	67.2 (4.9)	79.2 (5.2)
6-7	41	40	63.9 (5.2)	79.2 (5.2)
7-8	38	20	60.5 (5.4)	75.7 (6.3)
8-9	36	20	58.9 (5.5)	75.7 (6.3)
9-10	35	14	58.9 (5.5)	70.3 (7.8)

SE = Standard Error. Logrank test: χ^2=3.570, df=1, P=0.06 (Not quite statistically significant).

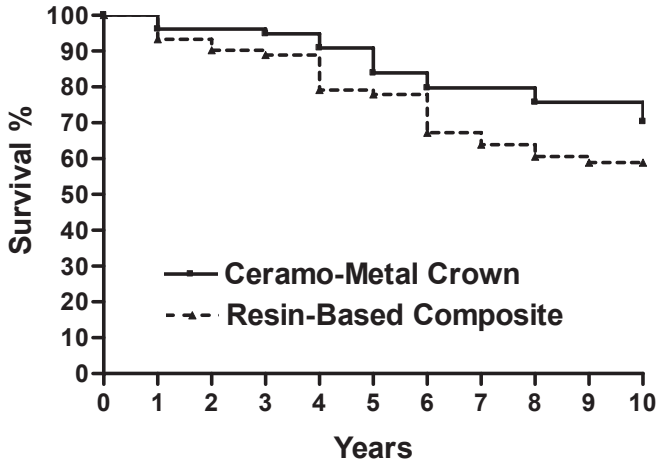

Figure 2. *Cumulative survival estimates for the anterior direct RBC and anterior indirect CMC restorations over 10 years.*

Because the restorations were placed by two prosthodontists in a dental hospital, the results may not be applicable to those found in general practice. There also were relatively more anterior than posterior restorations placed, and most of the larger posterior restorations were FGCs and CMCs, with only 12 Class II/crown RBCs (Table 2). Many patients did not attend for reviews over the longer term. Fourteen of the original 25 patients attended for up to 5 years and seven patients attended for up to 10 years. Therefore, because of the relatively small sample sizes, the restoration survival findings of the present study should be interpreted with caution. However, the favourable findings are supported by a recent 5-year prospective trial involving 81 posterior and 18 anterior non-vital teeth, restored by 18 dentists using either direct metal post and all-composite crowns or post-free all-composite crowns, where only two failures occurred[16]. These all-composite crowns showed a similar high survival to CMC crowns placed in a parallel trial involving the restoration of 319 non-vital teeth.[17] Therefore, large RBC restorations may be a potential alternative to the placement of CMC restorations, but further large long-term controlled trials are required for confirmation.

There were relatively higher proportions of failures for the RBC and CMC than for the posterior FGC restorations, and most of the RBC and CMC failures occurred with the anterior restorations (Table 3). However, there were proportionally more anterior than posterior restorations placed (Table 2). Other clinical studies also have reported the need for replacements and repairs of RBCs when used to restore localized anterior tooth wear[9,14]. Maintenance of the RBCs was reported as being straightforward and the repairs, if necessary, were readily accomplished. As in the present study, the principal cause of RBC failure was bulk fracture[14], which is a limitation of the material. A relatively higher number of CMC than RBC restorations were either lost or had pulpal problems (Table 3), which was probably related to more extensive tooth preparations associated with the CMCs. Consequently, there were more root canal therapies and tooth extractions required in this group. In some instances, the dislodged CMCs were able to be recemented. The compliance of patients in wearing their removable partial dentures was not known.

Overall, there was no statistically significant difference in the cumulative survivals of all the direct and indirect restorations over the 10-year period (Table 4, Fig 1). Although there was a strong trend for lower cumulative survival estimates for the anterior direct RBCs than for the anterior indirect CMCs (Table 5, Fig 2), the difference was not statistically significant at the 5% level. A larger patient sample size might have the power to show a statistically significance difference between the two groups of restorations at 10 years.

The anterior RBC cumulative survival of approximately 78% after 5 years can be compared with the cumulative survival of 50% after 4.75 years for a direct RBC in one other study of localized anterior tooth wear in a younger group of patients [9]. This survival of 50% resulted from minor as well as major failure reasons. Minor failures included less-than-ideal restoration characteristics, which may not require any operative intervention. When major failures only are considered, then the cumulative survival was approximately 70%[9], which is similar to that in the present study.

CONCLUSION

Within the constraints of the operator, patient and posterior restoration numbers, this retrospective case series study found no statistically significant difference between the survivals of direct and indirect restorations placed for the treatment of advanced tooth wear in older persons. However, there was a strong trend for lower survivals for the direct than for the indirect placement restorations. At 10 years, cumulative survival estimates were 62.0% for all direct restorations and 74.5% for all indirect restorations (P=0.23). Survival estimates were 58.9% for anterior RBC restorations and 70.3% for anterior CMC restorations, which was marginally significant (P=0.06). RBC restorations usually failed from fractures, and CMC restorations from complete losses. The management of such failures was usually more straightforward for the RBC restorations, as the CMC failures often required associated root canal therapies and extractions. The selective placement of large direct RBC restorations may be a potential cost–effective alternative to the placement of indirect CMC and FGC restorations for older patients with advanced tooth wear. However, large long-term controlled clinical trials are required for confirmation.

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