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Longevity of implant crowns and 2-unit cantilevered resin-bonded bridges

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Abstract

Objective: To compare "survival" and "success" of implant-supported crowns (ISC) and tooth-supported 2-unit cantilevered resin-bonded bridges (cRBB) in the rehabilitation of a bounded single tooth space (BSTS), after an observation period of $\geq$5 years.

Methods: A case–control study among subjects who received ISC or cRBB rehabilitation at a teaching hospital. The (i) *survival* (retention in mouth) and (ii) *success* (absence of complications requiring intervention) for the ISCs and cRBBs were compared (overall, supporting structures and that of the prostheses). Rates of survival and success were compared using log-rank statistics. Prevalence of survival and success (categories) were compared by chi-square/Fisher's exact test.

Results: Seventy eight subjects participated in this study (39 ISC and 39 cRBB cases). Both had a mean observation time exceeding 100 months, $P > 0.05$. ISCs and cRBBs had similar survival rates: overall ($P = 0.96$), supporting structures ($P = 0.14$) and prostheses ($P = 0.44$) There was a significant difference in the rate of overall success between ISCs and cRBBs ($P = 0.03$), specifically with respect to the success rate of the supporting structures ($P = 0.03$). There was also a significant difference in the prevalence of supporting structures categorized as a "success": ISCs (69.2%) and cRBBs (89.7%), $P = 0.03$. Biological complications of supporting structures were more common among ISCs (25.6%) compared with cRBBs (7.7%), $P = 0.03$.

Conclusion: Implant-supported crowns and cRBBs in the rehabilitation of a BSTS survive similarly after at least 5 years. However, cRBBs had a higher success rate and were more frequently categorized as successful than ISCs. Notably, there were fewer biological complications of cRBBs supporting structures than ISCs.

In making a clinical decision of missing tooth replacement, an understanding of the consequences and outcomes of various treatments is required; longevity is one of the most commonly used parameters (Guckes et al. 1996; Anderson 1998; Carr 1998). For the most part, studies have focused on the issue of survival (retention in mouth), that is, time to retreatment of prosthesis and while a series of systematic reviews have shown a high level of survival for both implant-supported and tooth-supported prosthesis (Pjetursson et al. 2004a; Tan et al. 2004), it is noted that there are variations between the different types of fixed prosthesis and tooth-implant-supported combinations (Lang et al. 2004; Pjetursson et al. 2004b, 2007; Pjetursson & Lang 2008). The use of implant-supported crowns (ISC) in the rehabilitation of single tooth loss is promising (Henry et al. 1996; Levine et al. 1999; Wennstrom et al. 2005; Jung et al. 2008). However, treatment outcomes of the various types tooth-supported fixed partial dentures (FPD) in the replacement of a single missing tooth are unclear (Salinas & Eckert 2007).

It is acknowledged that survival outcomes in themselves are somewhat crude, and thus, there is a growing interest in "success" outcomes. Unfortunately, different criteria have been used to determine "success" in a treatment option (Torabinejad et al. 2007) making it even more difficult to compare outcomes between two or more treatment options. Nonetheless, success can be broadly categorized based on the presence or absence of biological and technical complications requiring intervention, that is, time to repair (Schmidlin et al. 2010).

The aim of this study was to compare the survival and success (prevalence and rate) of implant-supported crowns (ISC) and 2-unit cantilever resin-bonded bridges (cRBB) in the rehabilitation of a bounded single tooth space after at least 5-year clinical service.

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Material and methods

A case–control study (matched for age and location of restoration) was performed among subjects who had received ISC or cRBB at a university teaching hospital (Prince Philip Dental Hospital), with at least 5-year service life. Patient records were reviewed to identify suitable cases where a bounded ISC was provided and information on time of prosthesis connection (or time of implant placement if no prosthesis) and location recorded. These subjects were then matched by length of observation time and location to a group of subjects who had received cRBBs for a similar clinical scenario. Design principles of cRBBs (single pontic, single retainer) have been discussed previously using relatively unrestored teeth adopting a minimal tooth preparation approach. ~~Cementation with an adhesive resin cement using nickel chrome alloy as the framework~~ (Botelho 2000).

Subjects were assessed at a review appointment where a clinical and radiographic assessment was performed including a review of patient records. Patients were asked to recall any remedial treatment provided outside the teaching hospital. Survival was defined as retention in the mouth of the supporting structure and prosthesis at the time of clinical observation. Success was defined as absence of complications requiring treatment intervention beyond routine periodontal maintenance, and if present, classified according to complications arising from supporting structures or the prostheses itself. Survival and success time (i.e. time to retreatment/repair) was ascertained from clinical examination and patients' records and interviews. Modified from Berglundh et al. 2002; biological complications refer to any disturbances in the function the implant or tooth characterized by biological processes. Technical complications refer to collective term for mechanical damage of the implant/implant components and superstructures as well as the teeth and resin-bonded bridges.

Overall survival rate of both the supporting structures and prostheses of the two treatment modalities was presented in Kaplan–Meier plots and compared using log-rank statistics. In addition, the success rate of the supporting structures and prostheses as an integral unit of the two treatment modalities was compared using log-rank statistics. Following on, the prevalence of the first occurring complications (biological and technical) for both treatment modalities was compared using chi-square/Fisher's exact test statistics, that is, the presence of complications (yes/no) by restoration type.

Sample size calculation was conducted based on a hypothesis that a 5% annual difference in the repair (non-success) / replacement (non-survival) rate between ISCs and cRBBs would be significant giving an overall difference of 30% after an observation time of at least 5 years. Because there is no consensus of implant/cRBB success criteria, we based our calculation on survival only. The 10-year survival rates for ISC and RBB would be 89.4% and 65.0%, respectively (Pjetursson & Lang 2008). According to the Altman's nomogram (Petrie et al. 2002), with the significance level set at 0.05 and power of the study at 80%, a sample size required for each treatment option would be 35. To account for potential dropouts, an additional 10 subsets (five per group) were recruited.

This study was approved by the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster, Hong Kong (UW 10-450) for clinically reviewing patients who had received the above treatments at the PPDH.

Results

At schedule review appointments, 78 subjects, 39 with ISCs and 39 with cRBBs, were assessed. The profile of the study group is presented in Table 1. The mean observation time for ISCs was 108.1 months (SD 29.8) (median, 104.0 months; range, 68.0–197.0 months) and for cRBBs was 115.2 months (SD 31.4) (median, 109.0 months; range, 75.0–196.0 months). Thirty-two (82.1%) ISCs and 32 cRBBs were present at the review appointment, $P = 1.00$: Non-integrated implants ($n = 2$); implant fracture ($n = 1$); crowns remade for repeated screw loosen ($n = 1$); abutment-crown loosed ($n = 1$); poor fitting crown ($n = 1$); and abutment fracture ($n = 1$). Six cRBBs were lost by debonded, and one cRBBs was removed because of mistake in cementation. The overall mean survival time for the ISCs (survival of both supporting structure and prosthesis)

Table 1. **Profile of the ISC and cRBB group**

	% (*n*)		% (*n*)
Site of replacement			
Upper anterior	38.5% (15)	Lower anterior	0.0% (0)
Upper posterior	20.5% (8)	Lower posterior	41.0% (16)
~~Supporting structure~~			
~~ISC~~		~~cRBB~~	
With bone graft		*Abutment tooth*	
Yes	33.3% (13)	Incisor	28.2% (11)
Simultaneous	15.4% (6)	Central	28.2% (11)
Staged	17.9% (7)	Lateral	0.0% (0)
No	66.7% (26)	Canine	12.8% (5)
Immediately/early placement	7.7% (3)	Premolar	33.3% (13)
Fixture diameter		Molar	30.3% (10)
4.5 mm or more	15.4% (6)		
3.5 mm–4.5 mm	66.7% (26)		
Less than 3.5 mm	12.8% (5)		
Unknown	5.1% (2)		
Fixture length			
10 mm or more	94.9% (37)		
8 mm	5.1% (2)		
Submerged placement	76.9% (30)	*Pontic tooth*	
Non-submerged placement	23.1% (9)	Incisor	38.5% (15)
Implant brand		Central	17.9% (7)
Branemark	54.3% (20)	Lateral	20.5% (8)
Straumann	20.5% (8)	Canine	5.1% (2)
Calcitek	12.8% (5)	Premolar	33.3%(13)
Others including Nobel Replace,	15.4% (6)	Molar	23% (9)
~~Biohorizons~~a, Cresco, Frialit-2 and 2 unknown			
Prosthesis			
Cement retained	87.2% (34)	Mesial cantilever	59.0% (23)
Screw retained	7.7% (3)	Distal cantilever	23.1% (9)
No crown	5.1% (2)	Midline	17.9% (7)
Metal ceramic	87.2% (34)		
Zirconia	5.1% (2)		
No crown	5.1% (2)		
Loading			
Within 48 h	5.1% (1)		
Less than 3 months	12.8% (5)		
3 months or more	79.5% (31)		
No crown	5.1% (2)		

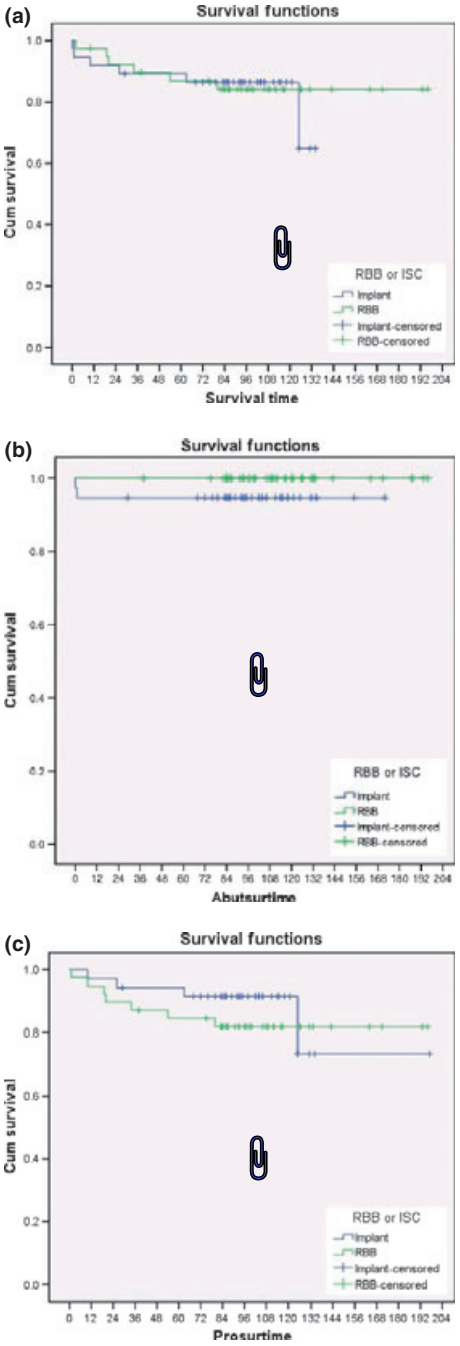

Fig. 1. (a) Kaplan–Meier life table comparing overall survival of cRBBs and ISCs. (b) Kaplan–Meier life table comparing survival of supporting structure of cRBBs and ISCs. (c) Kaplan–Meier life table comparing survival of prosthesis of cRBBs and ISCs.

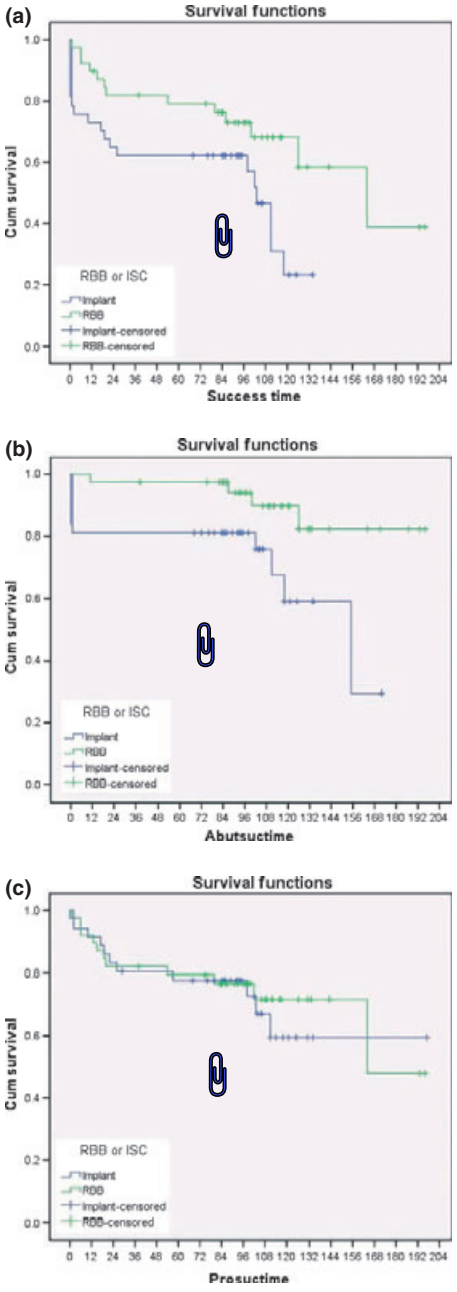

Fig. 2. (a) Kaplan–Meier life table comparing overall success of cRBBs and ISCs. (b) Kaplan–Meier life table comparing success of supporting structure of cRBBs and ISCs. (c) Kaplan–Meier life table comparing success of prosthesis of cRBBs and ISCs.

was 87.3 (SD 34.5) (median, 94.0) months. For cRBBs, the overall mean survival time (survival of both supporting structure and prosthesis) was 96.2 (SD 44.8) (median, 96.0) months. There was no significant difference in the survival rate of ISCs compared to cRBBs, $P = 0.96$ (Fig. 1a). Thirty-six (92.3%) of the supporting structures of the ISCs were present compared to 39 (100.0%) for the cRBBs ($P = 0.12$). The mean survival time of the supporting structures of the ISC (implant fixture) was 96.9 (SD 34.4) (median, 102.0) months and for the cRBBs (abutment tooth) was 113.7 (SD 33.6) (median, 109.0) months. There was no significant difference in the survival rate of the supporting structures for ISCs compared to the cRBBs, $P = 0.14$ (Fig. 1b). Thirty-three (84.6%) of the ISC's prosthesis were present at the review compared to 32 (82.1%) of the cRBBs' prostheses, $P = 0.76$, because one failed implant (non-survived) was subsequently replaced and restored with a crown (survived). The mean prosthesis survival time for the ISCs was 95.2 (SD 32.8) (median, 96.5) months and for the cRBBs was 96.3 (SD 44.9) (median, 96.0) months. There was no significant difference in the survival rate of the prosthesis of the ISCs compared to the cRBBs, $P = 0.44$ (Fig. 1c).

Eighteen (46.2%) of the ISCs and twenty-five (64.1%) of the cRBBs were complication free at review, $P = 0.07$. The mean overall success time for the ISCs (success of both supporting structure and prosthesis) was 64.2 (SD 47.5) (median, 85.0) months. For cRBBs, the mean overall success time (success of both supporting structure and prosthesis) was 88.8 (SD 47.6) (median, 93.0) months. There was a significant difference in the success rate of ISCs compared to cRBBs, $P = 0.03$ (Fig. 2a). At the examination appointment, 27 (69.2%) of the supporting structures of the ISCs were complication free compared to 36 (92.3%) of the cRBB-supporting structures ($P = 0.01$). The mean success time of the supporting structures of the ISC (implant fixture) was 84.1 (SD 46.2) (median, 94.0) months and for the cRBBs (abutment tooth) was 111.1 (SD 37.3) (median, 109.0) months. There was a significant difference in the success rate of the supporting structures of ISCs compared to the cRBBs, $P = 0.03$ (Fig. 2b). Furthermore, 25 (64.1%) of the ISC's prostheses were present and complication free, compared to 28 (71.8%) of the cRBBs' prostheses, $P = 0.47$. The mean prosthesis success time for the ISCs was 83.1 (SD 43.4) (median, 92.5) months and for the cRBBs was 89.0 (SD 47.8) (median, 93.0). There was no significant difference in the success rate of the prostheses of the ISCs compared to the cRBBs, $P = 0.76$ (Fig. 2c). Complications requiring intervention of the ISCs and the cRBBs are presented in Tables 2 and 3, respectively.

Further analysis of the complications relating to success was undertaken and "biological" and "technical" complications categorized on the basis of first occurrence (Table 4). Regarding the success of the supporting structures, biological complications that required intervention were more prevalent for ISCs (25.6%) compared to cRBBs (7.7%), $P = 0.03$. However, there was no significant difference in the prevalence of technical complications of the supporting structures of ISC compared to cRBBs, $P = 0.25$. In terms of success of the prostheses, there was no biological complication in either group. Furthermore, there was no significant difference

Table 2. **Implant-supported crowns complications requiring intervention in this study**

	Number of complications	Number of affected restorations	Number of first occur complications, that is non-success
Supporting structure			
Technical complications			
Cover screw loosen	1	1	1
Cover screw fracture	1	1	1
Implant fracture	1	1	0
Biological complications			
Non-integrated implants	3	2	2
Peri-implantitis (5 mm probing depth & bleeding on probing) (Bragger et al. 2005)	6	6	3
Post-surgical complications (Include swelling, sequestrum, labial abscess, palatal dehiscence, soft tissue overgrowth and delayed implant healing)	7	5	5
Prosthesis			
Technical complications			
Abutment screw loosen	7	3	2
Veneer fracture	4	4	1
Abutment-crown loosen	1	1	1
Poor fitting implant crown	1	1	1
Screw restoration loss	3	3	2
Crown loosen	4	2	1
Abutment fracture	1	1	1
Biological complications			
Nil			

Table 3. **Cantilevered resin-bonded bridges complications requiring intervention of in this study**

	Number of complications	Number of restorations affected	Number of first occur complications, that is non-success
Supporting structure			
Technical complications			
Nil			
Biological complications			
Periodontitis (5 mm probing depth & bleeding on probing) (Bragger et al. 2001)	3	3	2
Caries under abutment	1	1	1
Periapical radiolucency (Orstavik et al. 1986)	2	2	0
Prosthesis			
Techanical complications			
Debonding	14	9	9
Veneer fracture	2	2	1
Mistake in cementation	1	1	1
Biological complications			
Nil			

in the prevalence of technical complications for the prosthesis of ISCs and cRBBs, $P = 0.60$.

Discussion

The mean observation time of this study was close to 10 years. To date, evidence of survival (and success) of resin-bonded bridges (RBBs) has typically involved studies of considerably shorter duration (Botelho et al. 2006; Pjetursson et al. 2008). Thus, the current study can provide valuable information on the long-term survival and success of these restorations. Of note, the different features of the ISCs were evident in terms of location, treatment procedure and approach, implant characteristics and their associated prosthesis.

In this study, the survival of the ISCs was high over time, and this concurs with previous 5- and 10-year reports (Jung et al. 2008). Likewise, survival of cRBBs was high, which concurs with previous data on 5-year studies (Pjetursson et al. 2008). The proportion of retained restorations was comparable for both treatment modalities, as was their survival rates. Furthermore, the survival over time of both the supporting structures and their associated prosthesis of both the ISCs and cRBBs were comparable. This would suggest that either treatment modality can produce a high rate of survival over 10 years.

Success was defined as absence of complications requiring treatment beyond routine periodontal maintenance. There was a significant difference in the rate of overall success between the two treatment modalities favouring cRBBs. Specifically, there was a greater success rate of the supporting structures of cRBBs (i.e. tooth) compared to that of

Table 4. **A comparison of the prevalence of the first occurring complications requiring intervention (non-success) for the ISCs and cRBBs**

	Yes %(number)	No %(number)	*P*-value
Supporting structure			
Technical complications			
ISCs	5.1 (2)	94.9 (37)	$P = 0.25^{\dagger}$
cRBBs	0.0 (0)	100.0 (39)	
Biological complications			
ISCs	25.6 (10)	74.4 (29)	$P = 0.03^{*}$
cRBBs	7.7 (3)	92.3 (36)	
Prosthesis			
Technical complications			
ISCs	23.1 (9)	76.9 (30)	$P = 0.60^{*}$
cRBBs	28.2 (11)	71.8 (28)	
Biological complications			
ISCs	0.0 (0)	100.0 (39)	Nil
cRBBs	0.0 (0)	100.0 (39)	

**P*-value obtained from chi-square test.
†*P*-values obtained from Fisher's exact test.

the ISCs (i.e. implant fixture), which is consistent with others findings (Holm-Pedersen et al. 2007). Furthermore, there was a higher prevalence of biological complications of the supporting structures requiring treatment interventions among ISC cases compared to cRBBs. The issue of biological complications with ISCs has been reported, and complications' such as peri-implantitis are noted to be common (Berglundh et al. 2002; Jung et al. 2008). Complications associated with cRBBs success is not well documented in the literature aside from technical complications of the prosthesis, namely debonding (Pjetursson et al. 2008) that is the major cause of failure (non-survival).

In summary, the findings of this study would suggest that while both ISCs and cRBBs have comparable survival, the long-term success rate is lower and the prevalence of complications higher among ISCs compared to cRBBs in a study of close to 10-year observation. As noted, the heterogeneous nature of the ISCs group in this study may have attributed to such findings and this requires further investigation. Further investigations on a homogenous comparison group using a single implant system may yield different results. This result, however, may approach to that in the community practice. In addition, there is a need for further studies of 10-year duration or more to document success rates as well as types of complications for cRBBs to systematically address whether cRBBs are a preferable treatment option for single tooth loss in a bounded space.

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