A two-year clinical study of metal-ceramic and metal-polymer crowns

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Abstract: The purpose of this study was to compare full metal crowns with two different types of veneering material – ceramics and polymer after a two-year period in a function. The aim was to evaluate the changes of occlusal relief, marginal adaptation, break of material, changes of shape and color and gingival status. One hundred and two crowns were examined in 34 patients immediately after cementation, and they were reviewed within two years of crown placement. These fixed restorations were checked according two modified US Public Health Service System criteria. After two years the crowns were found clinically intact in 94 % for metal-ceramics versus 98 % for metal-polymer. No crown was lost. There were found significant differences in positions of a crown margin between both materials and marginal adaptation between initial (baseline) and follow-up results. Gingival health at baseline was related in optimal in 67 % versus 77 %, after two years in 43 % versus 71 %. Slight mismatch in color occurred in 0 versus 60 % crowns, obvious mismatch was apparent in 0 versus 21 % crowns after two years. Within the limitations of this study, it was found that the examined metal crowns with two different veneerings are very stable fixed restorations, mechanical resistance and integrity of polymer material was surprisingly good but its color stability presented mismatch after two-years period. Ceramic veneering was excellent in color match but there were three visible cracks of the ceramic layer.

Key words: Dentistry – Full crowns – Dental ceramics – Dental polymers

This research has been supported by the Grant Agency of the Ministry of Health of the Czech Republic No. 6881-3.

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 Prague Medical Report / Vol. 105 (2004) No. 1, p. 13–20

Introduction

In last decades the metal-ceramic (M-C) crown and metal-polymer (M-P) crown materials have become the restoration of choice to reconstruct the esthetics and structural integrity of discolored, heavily restored, fractured, or worn teeth [1]. Esthetic advantages of ceramics have brought about a significant reduction in the use of gold and gold-acrylic combinations, while its strength characteristics have overcome the inherent fragility of the traditional ceramic materials [2,3].

Metal-ceramic crowns are the world wide standard for tooth colored full crowns. Forty years of evolution (US patent 1962) have resulted in a crown being stable treatment in the whole dental arch [4]. The retrospective studies [1,5] have shown excellent fit, durability, and longevity. However, there are some problems that need consideration, such as wear of the opposing dentition, wear or breakage of porcelain with exposure or possible exposure of underlying metal, need for excellent lab skills to produce life-like esthetics.

Classical metal crowns with acrylic facings were introduced in the dental offices at the end of forties. Technical problems with the bond stability of the veneering were solved by *Musil et al.,* at the beginning of eighties and helped to enhance the theory and practice of metal-ceramic reconstructions [6].

What are indications for resin materials? Clinical Research Associates (CRA) recommends resin for the following situations: minimal wear of opposing teeth, useful for long-span fixed prostheses, easier for lab technicians, less cost, and repair is less difficult. Ceramics is biologically inert, material does not exhibit general wear over time, surface does not roughen, optimal esthetics is possible initially and over time, and long clinical history is known [7].

Still there are only a few longitudinal studies and comparisons between classical crowns with polymer – based facings and metal – ceramics reconstructions [1,8,9,10]. But long-term optimum of described two different prosthetic systems is not fully defined in the dental literature available.

In 2003 all EU countries fully adopted "Directive 1999/44/EC of the European Parliament and of the Council of 25 May 1999 on certain aspects of the sale of consumer goods and associated guarantees". From the prosthodontic point of view the most important article is No. 5, namely the time limits "The Seller shall be held liable under Article 3 where the lack of conformity becomes apparent within 2 years as from delivery of the goods". Due to these circumstances

Table 1 – Distribution of teeth

Teeth	Incisors and canines		Premolars		Molars		Total
	Upper	Lower	Upper	Lower	Upper	Lower	102
M-C	5	4	11	7	14	13	54
M-P	13	4	6	10	6	9	48

M-C – metal-ceramic crown; M-P – metal-polymer crown

the authors decided to check the real quality not only of the esthetic facing but also of the whole crowns including metal framework. The purpose of this study was to compare metal crowns with two types of veneering materials during a defined two-year period.

The hypothesis was that metal-ceramic crown reconstructions would be excellent in all characteristics evaluated after two years: surface and color stability, marginal integrity and gingival status. Another question arose whether the resin veneering can be considered as a method of choice?

Materials and Methods

Two types of crowns were investigated in 34 patients (16 men and 18 women) who volunteered to participate in the study. The distribution of teeth was described in Table 1. The crowns were manufactured in a private dental office by a single clinician. The ethical approval for the study was obtained from the General Teaching Hospital – 1st Medical Faculty of Charles University Ethics Committee, Prague. The patients were asked to consider joining the trial. The objectives of the study were explained to the patients who were given the opportunity to give informed consent to the experiment. They obtained an explanatory letter providing details of the project.

The total number of crowns was 102 and they were of two different types of reconstruction. Fifty-four crowns were made of nickel-chromium alloy Wiron/Bego, Germany and ceramic veneering Vita Omega/Vita, Germany. Twenty-nine crowns were prepared from nickel-chromium alloy Wiron/Bego, Germany and 19 crowns from low gold content alloy Aurix/Safina, Czech Republic with polymer veneering Sinfony/Espe, Germany and Evicrol/Dental, Czech Republic. The materials were used in accordance with the manufacturer's instructions.

Clinical procedures. Abutment teeth were prepared for metal-ceramic crowns with the gingival margin located at the gingival level. For metal-polymer crowns the clinician used slightly subgingival (0.5 mm) preparation. Impressions were taken using standard vinylpolysiloxane material Dentaflex/Dental, Czech Republic. All prepared teeth were treated with temporary crowns based on resin. The crowns were constructed by standardized techniques.

The teeth were cleaned using cotton pellets after removal of provisional crowns. New crowns with sandblasted internal surfaces were luted with phosphate cement. Immediately after cleaning all over hanged pieces of luting material, the same clinician examined the new crown restoration in accordance to the modified the US Public Health Service System criteria (USPHS). Then all patients were instructed in recommended methods of oral hygiene.

Two years later, the patients were recalled. Examination of treated teeth with crowns was performed by two different clinicians. Their assessments were unified and written in a special questionnaire with USPHS criteria.

Table 2 – Clinical evaluation at two years

RELATION TO VESTIBULAR GINGIVA (B, F)						
Crown	At gingival margin		Above gingival margin		Below gingival margin	
	baseline	follow-up	baseline	follow-up	baseline	follow-up
M-C (x)	23	19	9	35	22	0
%	42	35	17	65	41	0
M-P (x)	0	7	0	27	48	14
%	0	15	0	56	100	29

RELATION TO ORAL GINGIVA (B, F)						
Crown	At gingival margin		Above gingival margin		Below gingival margin	
	baseline	follow-up	baseline	follow-up	baseline	follow-up
M-C (x)	22	18	10	32	22	4
%	41	33	18	59	41	8
M-P (x)	0	10	0	21	48	17
%	0	21	0	44	100	35

GINGIVAL HEALTH ASSESSED VESTIBULARLY AND ORALLY (F)								
Crown	Optimum		Visible inflammation		Bleeding on probing		Metallic spot	
	baseline	follow-up	baseline	follow-up	baseline	follow-up	baseline	follow-up
M-C (x)	36	23	16	28	2	3	1	2
%	67	43	30	52	3	5	2	3
M-P	37	34	8	9	3	5	0	0
%	77	71	17	19	6	10	0	0

INTEGRITY OF RESTORATION								
Crown	Intact		Crack visible on		Fracture present		Crown lost	
	baseline	follow-up	baseline	follow-up	baseline	follow-up	baseline	follow-up
M-C	54	51	0	3	0	0	0	0
%	100	94	0	6	0	0	0	0
M-P	48	47	0	0	0	1	0	0
%	100	98	0	0	0	2	0	0

SECONDARY CARIES				
Crown	Not visible		Caries evident	
	baseline	follow-up	baseline	follow-up
M-C	54	52	0	2
%	100	96	0	4
M-P	48	47	0	1
%	100	98	0	2

MARGINAL ADAPTATION								
Crown	Explorer does not catch		Explorer catches		Crevice at margin		Obvious crevice	
	baseline	follow-up	baseline	follow-up	baseline	follow-up	baseline	follow-up
M-C (x)	54	42	0	11	0	0	0	1
%	100	78	0	20	0	0	0	2
M-P (x)	47	34	1	13	0	1	0	0
%	98	71	2	27	0	2	0	0

Table 2 – continue

GRADED FOR VESTIBULAR AND ORAL MARGINS (F)								
Crown	No discoloration		Slight staining		Obvious staining		Gross staining	
	baseline	follow-up	baseline	follow-up	baseline	follow-up	baseline	follow-up
M-C (x)	54	48	0	5	0	1	0	0
%	100	89	0	9	0	2	0	0
M-P (x)	48	31	0	4	0	9	0	4
%	100	65	0	8	0	19	0	8
COLOR MATCH (F)								
Crown	Good color match		Slight mismatch		Obvious mismatch		Gross mismatch	
	baseline	follow-up	baseline	follow-up	baseline	follow-up	baseline	follow-up
M-C	54	54	0	0	0	0	0	0
%	100	100	0	0	0	0	0	0
M-P	13	9	35	29	0	10	0	0
%	27	19	73	60	0	21	0	0

M-C – metal-ceramic crown, M-P – metal-polymer crown; B, F – significant difference between both materials using Fischer exact test ($P<0.05$); at baseline (B), follow-up (F) or both (B, F); (x) – significant difference between baseline and follow-up results

Statistical analysis. The initial and follow-up results were summarized. Table 2 presents results concerning crowns with statistical analysis correlating differences between both materials using Fischer exact test for quadruple table ($P<0.05$) and significant difference between initial and follow-up results.

Results

The clinical conditions of crowns are summarized in Table 2. All 102 crowns investigated in this in-vivo study stayed in the function for the whole period. No crown was lost during the two years period. Most of the crowns were found clinically intact (94.0 % metal-ceramic (M-C) versus 98 % metal-polymer (M-P) (Fig. 1, 2, 3, 4). Cracks were more frequent in ceramics (three crowns – Fig. 5). One fracture was detected in polymer veneering (Fig. 6).

There were found significant differences in positions of a crown margin between both materials and marginal adaptation between initial and follow-up results. The labial or buccal coronal margin of metal-ceramic crowns (two-years recall) was recorded as being at the level of the adjacent gingiva or above the gingival margin for 100 % crowns. Metal-polymer crowns were after two-year period inserted mainly above the gingival margin (56 %). There was no significant difference between vestibular or oral coronal margin placements. The classical metal crowns with acrylic facings were localized subgingivally in the initial examination. There was significant difference in position of a crown margin at the follow-up examination (Fig. 7 and 8). The metal-ceramic crowns were mainly inserted at gingival margin (initially) and crown borders moved to the supragingival position (65 %). The significant difference was observed.

Gingival health at baseline was related in optimal in 67 % (M-C) versus 77 % (M-P), after two years in 43 % (M-C) versus 71 % (M-P). Significant difference was present in metal-ceramic material.

Secondary caries was evident in 4 % (M-C) versus 2 % (M-P) at follow-up examinations (Fig. 9). After two years, a slight mismatch in color occurred in 0 versus 60 % crowns, obvious mismatch was apparent in 0 versus 21 % crowns. Discoloration assessment presented a statistical difference in both materials.

Gingival health at the vestibular or oral aspect of the crowns at baseline was rated as optimal in 67 % versus 77 % (Fig. 1, 2, 3, 4), visible inflammatory changes were found in follow-up 52 % (M-C) versus 19 % (M-P). Bleeding on probing was detected in 5 % (M-C) versus 10 % (M-P).

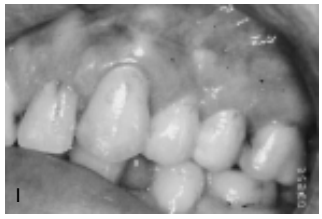
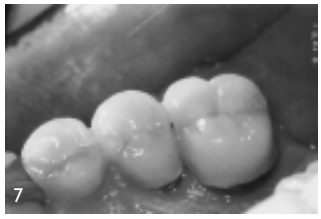


Fig. 1 – Metal-ceramic crown 23 in situ – baseline.
Fig. 2 – Metal-ceramic crown 23 in situ – follow-up.
Fig. 3 – Metal-polymer crowns 35, 36 – baseline.

Fig. 4 – Metal-polymer crowns 35, 36 – follow-up.
Fig. 5 – Crack of ceramic veneering – tooth 23.
Fig. 6 – Defect of metal crown 36.



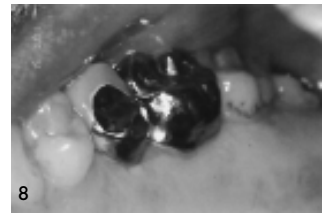


Fig. 7 – Supragingival position of a crown margin (M-C) – tooth 25, 26.
Fig. 8 – Subgingival position of a crown margin (M-P) – tooth 25.
Fig. 9 – The presence of caries: metal-ceramic crown 46.

Marginal adaptation was rated as contiguous with the existing anatomic form in 78 % (M-C) versus 71 % (M-P), and explorer catches in 20 % (M-C) versus 27 % (M-P).

Discussion

This study presents data of the status of porcelain-fused-to-metal crowns and conventional metal crowns with polymer facings after the two-year use. The metal frame for both techniques was very stable. *Walton* [1,11] in his 10-year metal-ceramic longitudinal study and *Erpenstein et al.* [9] in 15-year C+B restoration overview confirmed that 83 % of ceramic restorations and 84 % of resin reconstructions were still functional. Differences between both the systems described were obvious. Long-term clinical success of metal-ceramic crowns [1,10,11] is based on their mechanical stability, smooth and leak-proof surface. Results of the evaluation indicated that the color stability was excellent. Well-finished margins protected periodontal tissues. The restorative technique had a low incidence of fracture; the interproximal contacts were not open. The one- and two-year examination of the full ceramic crowns showed that only from 92 % and 95 % restorations were found to be intact [12,13,14].

Different results were observed in conventional filled resin veneer restorations. In the present study, the esthetic characteristics of the crowns were not considered satisfactory. Only 10 % of crowns had optimal visual quality. Slight staining of gingival margin, loss of transparency, smaller translucency, and regular color mismatch was detected. After four years the overall degradation of conventional veneers was confirmed by long-term clinical research of CRA [2].

Lakatos et al. [15] described in vitro that non-precious metallic framework may lead to corrosion phenomena and/or veneer detachment influencing the long-term clinical performance. Our study confirmed that metal-polymer crowns from non-precious alloys changed the transparency and translucency of facing. Ceramic veneer in metal-ceramic crowns fully protected the non-precious metallic framework and discoloration was not evident.

It was surprising that there were no significant differences between both systems in gingival status, and precision of marginal adaptation. Well-finished margins protected periodontal tissues. The same results were obtained by *Burke et al.* [12], who evaluated full ceramic crowns in one-year study. The results depend mainly on precise lab and dental office skills to produce a perfect marginal fit. The type of veneering material had only minimal influence on gingival health.

Caries was most commonly reported as being the major cause of the failure of fixed prostheses [1]. In our evaluation the presence of caries was evident. The margin fit was good, but plaque accumulation on rough surface helped to caries manifestation.

Conclusion

This study has reviewed the clinical characteristics and outcome of metal ceramic and polymer veneer crowns over a two-year period. The treatment was stable, and the integrity of restoration was very good. Marginal adaptation and gingival health was compromised. The esthetic quality of metal-polymer crowns was insufficient.

Are we able to accomplish the two-year guarantee of crowns? Metal frameworks are very stable; mechanical properties are reliable, and veneering materials stay in function. It is evident that longevity of the crown materials described is sufficient. The gingival health depends on the hygiene level, not on the used materials. Longevity of restoration also depends on esthetic stability. This feature can be guaranteed only by ceramics.

References

1. WALTON T. R.: A 10-year longitudinal study of fixed prosthodontics: Clinical characteristics and outcome of single-unit metal-ceramic crowns. Int. J. Prosthodont. 1999, 6, p. 519–526.
2. FILLED POLYMER CROWNS. Clinical Research Associates Newsletter 1998, 10, p. 1–2.
3. KERSCHBAUM T., SETH M., TEENWEN U.: Verweildauer von kunststoff- und metallkeramisch verblendeten Kronen und Bricken. Dtsch. Zahnarztl. Z. 1997, 52, p. 540–544.
4. WEINSTEIN M., KATZ S., WEINSTEIN A. B.: Fused porcelain-to-metal teeth. US patent 3052, 1962, p. 982.
5. BELL A. M., KURZEJA R., GAMBERG M.G.: Ceramometal crowns and bridges. Focus and failures. Dent. Clin. North Am. 1995, 29, p. 97–105.
6. MUSIL R., GARSCHKE A., TILLER H. J., BIMBERG R.: Neue Aspekte des Kunststoff-Metall-Verbundes in der Kronen- und Brückentechnik. Dental Labor. 1982, 30, p. 1711–1715.
7. RESIN CROWNS, FOUR-YEAR CLINICAL STATUS. CRA Newsletter 2001, 25, p. 1–3.
8. HOFMANN M.: Ästhetische Langezeitwirkung von kunststoffverblendetem Zahnersatz. Dtsch. Zahnarztl. Z. 1980, 35, p. 849–858.
9. ERPENSTEIN H., KERSCHBAUM T., FISCHBACH H.: Verweildauer und klinische Befunde bei Kronen und Brücken. Dtsch. Zahnarztl. Z. 1992, 47, p. 315–319.
10. LOVGREN R., ANDERSSON B., CARLSSON G. E., ODMAN P.: Prospective clinical 5-year study of ceramic-veneered titanium restorations with the Procera system. J. Prosthet. Dent. 2000, 84, p. 514–521.
11. WALTON T. R.: An up to 15-year longitudinal study of 515 metal-ceramic FPDs. Part 1: Outcome. Int. J. Prosthodont. 2002, 15, p. 439–445.
12. BURKE F. J. T., HUSSEY D. L., MCCAUGHEY A. D.: Evaluation of the one-year clinical performance of dentin-bonded ceramic crowns and four case reports. Quintessence Int. 2001, 32, p. 593–601.
13. KESLEY W. P., CAVEL W. T., BLANKENAU R. J., BARKMEIER W. W., WILERDING T. M., MATRANGA L. F.: Two-year clinical study of castable ceramic crowns. Quintessence Int. 1995, 26, p. 15–20.
14. STATUS REPORT: All ceramic crowns – 2001. CRA – Newsletter 2001, 25, p. 1–2.
15. LAKATOS S., ROMINU M., NEGRUTIU M., FLORITA Z.: The micro-leakage between alloy and polymeric materials in veneer crowns. Quintessence Int. 2003, 34, p. 295–300.