



## A retrospective multicenter study comparing metal–ceramic and composite single crowns performed in public general dentistry: 5-year results

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### ABSTRACT

**Objective** The aim of this study was to evaluate and compare the 5-year survival and complication rate of metal–ceramic (MC) and composite single crowns performed within Public Dental Service, general dentistry, in three Swedish counties and with patients' gender, tooth position, root canal treatment and the presence of a post-and-core taken into account.

**Methods** Data were collected from dental records of 600 patients who had received either an MC ( $n = 300$ ) or a composite ( $n = 300$ ) crown on a premolar or molar tooth in the year 2005 and where 5 years of follow-up data were available. Status at treatment completion and at follow-up was recorded, together with any history of intervention during the follow-up period.

**Results** The 5-year survival rate for MC crowns was higher than for composite crowns (93% versus 70%;  $p < 0.001$ ). This difference was stable, irrespective of the county, patients' gender or tooth position. No gender difference in survival rate was seen for MC crowns, while the survival of composite crowns was significantly higher among women than among men (75% versus 65%;  $p < 0.05$ ). For MC crowns, there was a tendency toward a lower survival rate for endodontically treated teeth without a post-and-core (83%) as compared to those provided with a post-and-core (93%) and to vital teeth (94%). Surviving composite crowns had recordings of significantly more complications than MC crowns ( $p < 0.001$ ).

**Conclusion** On premolars and molars, MC crowns have a better medium-term prognosis and fewer complications than composite crowns.

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Composite resins; dental crowns; follow-up study; metal–ceramic restorations

### Introduction

Metal–ceramic (MC) single crowns have been used for more than 40 years and have been considered the gold standard among indirect crowns. Several studies conducted in private practices, dental schools and specialist clinics present good medium- and long-term results, with 5-year survival ranging between 90 and 97.5%, and 10-year survival above 80%. [1–6] In a meta-analysis including three prospective and three retrospective studies, Pjetursson et al. [7] reported a 5-year survival of 95.6% for MC crowns. An alternative to an MC crown is a direct-placed composite crown that demands less removal of tooth substance. A direct composite crown can (at least in a short-term perspective) be less expensive and time-consuming in the dental operator.

In a prospective 3-year follow-up study, no significant difference in survival of endodontically treated teeth restored with either a cast crown or with direct composite restoration was found. [8] A 3-year survival rate of 91.6% for indirect composite resin crowns placed in a university setting has been reported. [9] Another prospective study, also in a university setting, reported a 5-year survival rate of 86.6% for direct and indirect composite cuspal restorations. [10] Ohlmann et al. [11] compared, in a randomized clinical trial, indirect polymer crowns with MC or ceramic crowns, and found more complications and a higher rate of wear for polymer crowns.

Several factors may affect the prognosis for a crown, and may differ between direct composite restorations

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and MC crowns. Patient-related factors such as oral hygiene, diet, bite force and bruxing habits as well as the extent of tooth substance loss and tooth vitality, and technical- and operator-related aspects may all contribute.[1,3,4,12–15]

Teeth with extensive loss of tooth substance have an inferior resistant form for restorative materials and may, therefore, be more prone to complications and failure of restorations.[12,13] Significantly higher failure rates have been reported for single crowns on non-vital teeth as compared to those on vital teeth.[1,14] On the other hand, the endodontic status of the tooth had no influence on the 3-year survival of less extensive direct composite restorations.[8] Good results in the medium-term follow-up of root canal-treated (RCT) teeth restored with or without a post system have been reported.[13,16] However, a systematic review from 2007 concluded that the survival rate for endodontically treated teeth without crown coverage decreased significantly over time;[17] this result is supported by a recent long-term follow-up from public specialist dental care in Sweden.[18]

Further, choice of material may affect the long-term result of both MC (type of metal and ceramic veneer and type of cement) and composite (type and combination of composite and bonding agent) crowns.[19,20]

Although MC crowns are a common treatment in modern general dentistry, there are surprisingly few recent studies evaluating their clinical performance as compared to that of direct-placed composite restorations.[21] Follow-up and outcome comparisons of teeth restored with either a composite restoration or an MC crown within public general dentistry are scarce, and the survival and complication rates in a 5-year perspective are not known. Therefore, the primary aim of this study was to evaluate the 5-year survival of MC crowns and composite crowns performed in public general dentistry in three Swedish counties. An additional aim was to explore the frequency of complications and, finally, to relate the crown survival rate to patient gender and tooth position, and to root canal treatment with or without a post-and-core.

The hypothesis was that MC crowns have a significantly higher 5-year survival than composite crowns, irrespective of patient gender and tooth position. A secondary hypothesis was that teeth without a root canal treatment would present higher survival rates than teeth with a root canal treatment with or without a post-and-core.

## Materials and methods

### Design

In this retrospective study, data from 600 patients within the Public Dental Service, general dentistry in three

counties in Sweden, were collected from dental records. From each county, data for 100 patients with an MC crown and 100 patients with a direct composite crown were collected. The patients were randomly selected from patient lists, generated from the dental record system, of all MC and composite crowns placed in the year 2005. If the randomly selected patient did not fulfill the inclusion criteria, the next patient on the list was chosen. At data extraction, all information was anonymized and registered in paper format. The study was commenced after approval from the regional ethical review board in Uppsala, Sweden, 30 May 2012, Dnr. 2012/198.

To fulfill the inclusion criteria, patients ( $\geq 20$  years old at treatment) should have been provided with an MC or a composite single crown within general dentistry in the year 2005, the crown being on a premolar or molar tooth in the maxilla or mandible. Follow-up data 4–8 years after treatment completion had to be available. Only one crown per patient was included. Teeth restored with porcelain crowns, gold crowns without veneer or crowns incorporated into a multi-unit fixed dental prosthesis were excluded.

### Subjects and procedures

Data were collected from September 2012 to January 2013 for the 600 patients provided altogether with 300 composite crowns and 300 MC crowns during 2005. The following data were retrieved from the dental records: type of restoration, patient age at crown placement, gender, tooth position, the endodontic status of the tooth and the presence or not of a post-and-core. The records were examined, and available digital radiographs were analyzed from the day of crown placement up to the dental recording made closest to 5 years after crown placement. All recordings of complications and interventions concerning the actual tooth were extracted. If the crown was lost, the follow-up was terminated; hence, follow-up time could be less than 5 years.

### Outcome measurements

Crown survival and complications (fracture of the crown, loss of retention, secondary caries, endodontic complications, etc.) were registered. In the present study, survival was defined as the crown being still in place at the 5-year follow-up with or without modifications.

### Statistics

Survival and complications were described and cross-tabulated in bivariate comparisons using Chi-square

tests. Logistic regression analyses were performed with survival at the 5-year follow-up as the dependent variable. Descriptive and analytical statistics were calculated using Statistical Package for Social Science version 21.0 (SPSS Inc., IBM, Chicago, IL).

## Power analysis

Based on the assumption that the 5-year survival for MC crowns and composite crowns in public general dentistry was 90% and 80%, respectively, a power analysis for a double-sided test with a  $p$  value of  $<0.05$  and a power of 80% indicated that 200 patients in each group were required. To allow for analyses by patient gender and endodontic status, a total of 600 patients were included.

## Results

### Sample characteristics

The study included 320 women and 280 men (mean age: 57.5 years; SD: 12.0), equally distributed between the two groups of different crown types (Table 1). The tooth positions were similarly distributed for the two crown type groups, with the most common position being mandibular molars. The proportion of RCT teeth was slightly higher in the composite group while the proportion of RCT teeth provided with a post-and-core was higher in the MC group (Table 1). Among the 102 MC crowns with a post-and-core, 32 had been provided with a Composipost®, seven with a screw post and 63 with a cast post. Of the 76 composite crowns provided with a post, Composipost® had been used in 35 and screw post in 41 cases. The mean follow-up time was 65 months (range: 43–90 months) for MC crowns and 67 months (range: 39–91 months) for composite crowns.

### Crown survival

The 5-year survival rate was significantly higher for MC crowns than for composite crowns (93% versus 70%; OR: 5.6;  $p < 0.001$ ; Table 2). Within groups, the survival rate for composite crowns was significantly higher among women than among men (75% versus 65%; OR: 1.7;  $p = 0.039$ ); other differences within groups were non-significant (Tables 2 and 3, model 2 and 3). However, for MC crowns, there was a tendency toward a lower survival rate for endodontically treated teeth without a post-and-core (83%) as compared to those provided with a post-and-core (93%) and to vital teeth (94%; Table 2).

The difference in survival rate between MC and composite crowns was stable (OR: 5.2), also with gender,

tooth position and endodontic status taken into account (Table 3, model 1).

## Complications

The number of complications increased by follow-up time. During the first year, no crown losses were recorded, and only 4% of the composite crowns and 0.3% of the MC crowns presented any complications. Composite crowns still in place at the 5-year follow-up presented significantly more complications than MC crowns still in place ( $p < 0.001$ ); only 154 (51%) of the composite crowns were still in place without complications.

**Table 1.** Sample characteristics, including gender and age, tooth position and endodontic status by group of crown type (metal–ceramic or composite).

|                                | Metal–ceramic crowns |         |      | Composite crowns |         |      |
|--------------------------------|----------------------|---------|------|------------------|---------|------|
|                                | Age                  |         |      | Age              |         |      |
|                                | <i>n</i>             | Mean    | SD   | <i>n</i>         | Mean    | SD   |
| Gender and age                 |                      |         |      |                  |         |      |
| Men                            | 141                  | 57.4    | 10.5 | 139              | 58.6    | 12.6 |
| Women                          | 159                  | 56.7    | 12.2 | 161              | 57.5    | 12.5 |
| All                            | 300                  | 57.0    | 11.4 | 300              | 58.0    | 12.5 |
| Tooth position                 | <i>n</i>             | %       |      | <i>n</i>         | %       |      |
| Molar maxilla                  | 52                   | 17      |      | 67               | 22      |      |
| Molar mandible                 | 123                  | 41      |      | 112              | 37      |      |
| Premolar maxilla               | 82                   | 27      |      | 77               | 26      |      |
| Premolar mandible              | 43                   | 14      |      | 44               | 15      |      |
| Endodontic status <sup>a</sup> | <i>n</i>             | valid % |      | <i>n</i>         | valid % |      |
| No root canal treatment        | 173                  | 58      |      | 142              | 48      |      |
| Root canal treatment           | 102                  | 34      |      | 76               | 26      |      |
| and post-and-core              |                      |         |      |                  |         |      |
| Root canal treatment           | 23                   | 8       |      | 79               | 27      |      |
| without post-and-core          |                      |         |      |                  |         |      |

<sup>a</sup>Five teeth (two MC and three composite) lacked information on endodontic status.

**Table 2.** Survival rate at 5-year follow-up by group of crown type (metal–ceramic and composite) and background variables.

|                         | Survival             |    |                  |    |
|-------------------------|----------------------|----|------------------|----|
|                         | Metal–ceramic crowns |    | Composite crowns |    |
|                         | <i>n</i>             | %  | <i>n</i>         | %  |
| Gender                  |                      |    |                  |    |
| Men                     | 133                  | 94 | 90               | 65 |
| Women                   | 146                  | 92 | 121              | 75 |
| All                     | 279                  | 93 | 211              | 70 |
| Tooth position          |                      |    |                  |    |
| Molar maxilla           | 50                   | 96 | 45               | 67 |
| Molar mandible          | 116                  | 94 | 82               | 73 |
| Premolar maxilla        | 73                   | 89 | 54               | 70 |
| Premolar mandible       | 40                   | 93 | 30               | 68 |
| Endodontic status       |                      |    |                  |    |
| No root canal treatment | 165                  | 94 | 105              | 73 |
| Root canal treatment    | 93                   | 93 | 51               | 68 |
| and post-and-core       |                      |    |                  |    |
| Root canal treatment    | 19                   | 83 | 55               | 70 |
| without post-and-core   |                      |    |                  |    |

**Table 3.** Logistic regressions in total (model 1) and separated by type of crown (model 2 and 3) with survival as dependent variable and potential discriminatory variables as independents.

| Independents                | Model 1, Total<br>(survival: yes = 488/no = 107) |         |                  | Model 2, Composite crowns<br>(survival: yes = 211/no = 86) |         |              | Model 3, Metal–ceramic crowns<br>(survival: yes = 277/no = 21) |         |          |
|-----------------------------|--|---------|------------------|--|---------|--------------|--|---------|----------|
|                             | OR   | 95% CI  | <i>p</i>         | OR   | 95% CI  | <i>p</i>     | OR   | 95% CI  | <i>p</i> |
| Type of crown               |  |         |                  |  |         |              |  |         |          |
| Composite 0/MC 1            | 5.2  | 3.1–8.8 | <i>&lt;0.001</i> |  |         |              |  |         |          |
| Gender                      |  |         |                  |  |         |              |  |         |          |
| Men 0/Women 1               | 1.4  | 0.9–2.2 | 0.132            | 1.7  | 1.0–2.9 | <i>0.039</i> | 0.7  | 0.3–1.7 | 0.401    |
| Tooth position <sup>a</sup> |  |         |                  |  |         |              |  |         |          |
| Premolar 0/Molar 1          | 1.3  | 0.8–2.1 | 0.251            | 1.1  | 0.7–2.0 | 0.628        | 1.9  | 0.7–4.8 | 0.193    |
| Endodontic status           |  |         |                  |  |         |              |  |         |          |
| No RCT                      |  |         | 0.499            |  |         | 0.814        |  |         | 0.169    |
| RCT with post 1             | 0.9  | 0.5–1.5 |                  | 0.9  | 0.5–1.6 |              | 1.0  | 0.4–2.8 |          |
| RCT without post 2          | 0.7  | 0.4–1.3 |                  | 0.8  | 0.4–1.6 |              | 0.3  | 0.1–1.1 |          |

Significant *p* values in italic.Nagelkerke  $r^2 = 0.147$  (model 1), 0.024 (model 2) and 0.048 (model 3).<sup>a</sup>Tooth position categorized into premolar or molar irrespective of jaw.**Table 4.** Number of complications for each crown and number and % of surviving and lost composite and MC crowns with complications during the 5-year follow-up.

| Type of crown               | Status at follow-up | Number of complications |    |    |    | Total number of crowns with complications |     |
|-----------------------------|---------------------|-------------------------|----|----|----|---|-----|
|                             |                     | 0                       | 1  | 2  | ≥3 | <i>n</i>                                  | %   |
| Composite<br><i>n</i> = 300 | Surviving           | 154                     | 49 | 8  | 0  | 57  | 27  |
|                             | Lost                | 0                       | 77 | 10 | 2  | 89  | 100 |
| MC crowns<br><i>n</i> = 300 | Surviving           | 273                     | 3  | 3  | 0  | 6   | 2   |
|                             | Lost                | 0                       | 20 | 1  | 0  | 21  | 100 |

Of the teeth restored with MC crowns, 273 (91%) were free of complications (Table 4).

The most common complications for composite crowns were a fracture of the crown and secondary caries. For MC crowns, loss of retention was the most common complication. During follow-up, RCT was performed on three of the teeth with MC crowns and on 15 of the teeth with composite crowns. Periapical surgery was performed on two teeth with MC crowns. At the 5-year follow-up, 24 (8%) of the teeth with a composite crown had been extracted, 20 of them were RCT. Nine (3%) teeth provided with an MC crown had been extracted, of which four were RCT.

## Discussion

Although crown therapy is a common treatment in general dentistry, there are only a few studies regarding its survival and many studies report on patients treated at specialist clinics or dental schools.[1,4,20] To our knowledge, this is the first study comparing the 5-year survival of MC and composite single crowns performed in general dental care within the Public Dental Service.

The 5-year survival for MC crowns (93%) was well in accordance with that presented by Pjetursson et al. [7] in a systematic review and exceeded significantly the survival of composite crowns (70%).

The rather low 5-year survival rate of composite crowns in the present study does not compare with Mannocci et al.'s [8] reporting on endodontically treated teeth, with preserved cusp structure, restored with either composite fillings or a composite resin core and an MC crown and 3-year survival rates of 93% and 95%, respectively. However, some important distinctions need to be pointed out. In the study by Mannocci et al.,[8] only premolars with limited loss of tooth structure were included, and the follow-up was limited to 3 years. To be included in our 5-year follow-up study, teeth had to have been restored with a composite crown; hence, a substantial part of the tooth structure was lost. The reduced amount of tooth structure may have resulted in both a reduction in the resistance and retention form in the crown preparation as well as a reduced amount of remaining enamel, possibly influencing the strength of the bonding. The gender difference in survival of composite crowns may be partly explained by differing bite forces and oral hygiene habits, composite crowns being more vulnerable than MC crowns.

The lack of difference in survival between jaws is in contrast to the results reported by Burke et al., [14] who, in a register study of crowns placed within the National Health Service General Dental Service, reported better survival for crowns in the lower jaw.

In addition to the difference in survival between MC and composite crowns, a significantly higher incidence of complications was registered for the surviving composite crowns, with an increasing number and severity of complications over time.



The different complications (fractures of the restoration or secondary caries for composite crowns and loss of retention or endodontic/periodontal complications for MC crowns) show that both biological and technical failures have an impact, which is in agreement with a study by De Backer et al., [4] where biological failures (caries) resulting in removal of the crown, in fact, were more common than other patient-related and technical failures.

The ultimate failure for a restoration is the removal of the tooth. The high proportion of RCT teeth restored with composite crowns that had been extracted indicates a higher risk for severe complications for RCT posterior teeth restored with composite crowns than with MC crowns. This is in accordance with a review by Stavropoulou & Koidis,[17] who concluded that "Root canal treated teeth restored with crowns show an acceptable long-term survival of 10 years while direct restorations have a satisfactory survival only for a short period." An RCT tooth has usually lost coronal and radicular tooth structure due to earlier restorations, caries and preparation during the endodontic treatment and offers, therefore, less retention for a crown as compared to a vital tooth. In our study, no significant differences in survival of MC or composite crowns were seen between RCT teeth restored with or without a post-and-core. However, although the RCT teeth without post were few within the MC group, the tendency toward a poorer outcome for these teeth calls for further attention.

There are some important drawbacks with the present study. This study had no strictly randomized groups, although there was randomness in the selection of the patients. Some selection bias may have been introduced by the inclusion criteria of available follow-up registrations. Further, the reason for choosing a composite crown or an MC crown could not be taken into account in this retrospective study on dental records. Obviously, a spectrum of circumstances, including costs and risk assessments, may have influenced the choice of crown type as well as the prognosis. Further, the dental records were found to not qualify for registrations of the type of cement, bonding systems or composite material, other factors that have been shown to affect the prognosis of crown restorations.[19] Thus, comparisons with other studies should be made with caution.

In daily practice, the prognosis should be evaluated and included in every treatment decision. Thus, the cost/benefit assessment for crowning a tooth has to cover also the expected service time for the tooth. Although a direct composite crown might initially be a cheaper alternative, the cost in a longer perspective might be considerably higher.

## Conclusion

Within the limitations of this study, the following conclusions could be made. The 5-year survival for MC crowns placed in the Public Dental Service, general dentistry, is good. MC crowns have a better medium-term prognosis and fewer complications than composite crowns on premolars and molars. Composite crowns have a lower survival rate in men than in women. There is no difference in 5-year survival among MC crowns placed on teeth with or without RCT, at least, when a post-and-core is used.

## Declaration of interest

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