Dental practitioners' evaluation of the metal–resin and metal–ceramic technique in the treatment with fixed prosthetic restorations

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To collect information on the use of the metal–resin and the metal–ceramic technique, a questionnaire survey among general practitioners was carried out in Bergen, Norway. Of the 20 dentists (16% sample) randomly selected among the private general practitioners, 17 (85%) responded. The results indicated that 45% metal–resin and 55% metal–ceramic constructions were inserted. Metal–ceramic crowns were selected for their favorable esthetics, whereas metal–resin appliances were preferred because of their repair possibilities and good marginal adaptation. Most dentists (70%) claimed that metal–resin restorations have a better marginal adaptation than metal–ceramic constructions. Location in the mouth, the general periodontal condition, and evidence of wear in the remaining dentition also appeared to influence the selection of the type of tooth-colored veneered crown. □ *Crowns; dental materials; questionnaire survey*

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Metal–ceramic and metal–resin crowns are the two types of restorations most commonly used to restore or replace teeth that need a tooth-colored facing. Whereas the metal–ceramic technique has gained ground in many areas in later years (1, 2), the metal–resin technique still appears to have a fair share of the market in the Scandinavian countries (3–5). In addition, the type of superconstruction often used in connection with many implant systems is based on metal–resin combinations (6). In this context metal–resin restorations include metal crowns and bridges with facings of either heat-cured acrylic resin or heat-cured or light-cured composites (macrofilled, microfilled, or hybrid materials).

The dentists' reasons for choosing one technique over another may be related to the different physical properties of the materials used (7, 8), their biologic and esthetic effects (9), patient opinions and desires, and, most likely, the manufacturers' marketing of their products.

Several studies have been conducted to evaluate the two techniques relative to technical quality in terms of marginal adaptation and long-term clinical performance of the veneers (3, 5, 10–16). For instance, Karlsson (5) observed severe marginal imperfections more frequently on ceramic-veneered metal crowns than on metal–resin crowns. Fracture of the ceramic material and wear of resin facings have been reported as significant clinical problems (5, 10). The length of service of single crowns and bridge retainers has also been focused on (10, 11). Walton et al. (10) concluded that metal–resin constructions in general have a life span of clinical service approximately twice that of metal–ceramic constructions. Caries and periodontal disease appear to be responsible for approximately 30–40% of the fixed restoration failures (10, 11). It has been suggested that the two types of restoration may be associated with somewhat different gingival reactions (12, 13). There seems to be no information on the frequency of caries

lesions related to the different types of fixed restorations, but a relationship between caries and the quality of the marginal adaptation has been shown (5). The ceramic facings have been rated better than metal–resin ones in terms of color stability (13) and wear resistance (17).

The present study was undertaken with the intent to collect information on the use of the two techniques, to record dentists' experiences with metal–resin and metal–ceramic crowns, and to rank the factors that influence the choice of technique.

Materials and methods

A questionnaire with return postage paid was mailed to a 16% random sample of the general dental practitioners in Bergen, Norway. The questionnaire included, in addition to simple inquiries on how frequently the two techniques were used, three categories of questions. One was concerned with the ranking of several listed physical and biological properties of the two types of restorations. The second category included several questions aimed at recording the practitioners' perceived opinions of the two techniques in terms of problems related to phases of the fabrication, treatment, and long-term clinical service. Also, patient complaints after cementation of the restoration, such as change in color of the veneer over time, were recorded. A third category of questions aimed at identifying characteristics of individuals treated with fixed prosthetic appliances and intraoral factors that tended to determine the dentists' selection of technique. The participants were asked to rank the most important factor as number 1 and the others in ascending order, giving the least important factor the highest number.

Of the 20 selected dentists 17 (85%) responded and returned the questionnaire. The extent of completion of the ranking of the questions varied somewhat between the dentists, as indicated in the tables.

The rank mean was calculated for each of the listed statements. The ranked answers for each question were subjected to a one-way analysis of variance by ranks (approximate test, nonspecific) (18).

The statistical testing was carried out at an overall level of significance of 5%.

Results

The dentists reported that they on the average used metal–ceramic restorations in approximately 55%, whereas the metal–resin technique was used in approximately 45% of the patients requiring conventional fixed prosthodontic treatment.

Of five commonly recognized advantages listed in Table 1 favorable esthetics and color stability were rated higher than resistance to wear and surface properties as reasons for choosing a metal–ceramic crown. The main stated disadvantages of such restorations were difficulties with making direct repairs and wear of opposing teeth (Table 2).

Among the advantages of metal–resin crowns the repair possibility and favorable marginal adaptation were rated as the most important factors (Table 3). In fact, 70.6% of the practitioners were of the opinion that metal–resin crowns have a better marginal adaptation, whereas the other 29.4% thought that the two types of restoration did not differ in this respect.

When asked about reasons for amendments of metal–ceramic crowns before cementation, poor marginal adaptation and inappropriate color of the veneer were those most frequently recorded (Table 4). The shape of the crown was also rated as a major reason for correction. More than 70% of the

Table 1. Rank order of stated reasons for using the metal–ceramic crown. The numbers in parentheses represent the number of missing responses to the different statements

	Rank mean
1. Esthetically favorable	26.6 (2)
2. Acceptable color stability	28.4 (2)
3. Acceptable wear resistance	24.3 (2)
4. No visible metal incisally	46.8 (3)
5. Favorable surface properties	52.1 (2)

DF = 4, H = 7.09, $p = 0.002$.

Table 2. Rank order of the stated disadvantages of metal–ceramic crowns. The numbers in parentheses represent the number of missing responses to the different statements

	Rank mean
1. Poor facilities for repairs	30.6 (3)
2. Wear of opposing teeth	38.5 (5)
3. Visible metal collar	43.8 (4)
4. Frequent veneer fractures	47.1 (5)
5. Poor margin precision	51.0 (6)
6. Poor facilities for making direct modifications	53.3 (5)
7. Difficulties in obtaining correct color	69.8 (5)
8. Difficulties in obtaining adequate shape	72.4 (6)

DF = 7, H = 22.07, p = 0.002.

Table 3. Rank order of the stated reasons for using metal–resin crown. The numbers in parentheses represent the number of missing responses to the different statements

	Rank mean
1. Making of direct repairs possible	19.8 (3)
2. Good margin adaptation	27.9 (3)
3. Good facilities for making direct modifications	37.6 (4)
4. Metal–resin crowns are esthetically acceptable	40.3 (4)
5. Metal–resin crowns represent the cheaper alternative	44.2 (5)

DF = 4, H = 14.75, p = 0.002.

dentists stated that the shade of the ceramic veneer initially often was too light.

Frequent causes of the need for improvement of metal–resin crowns in the laboratory

Table 4. Rank order of the reasons for correcting metal–ceramic restorations in the dental laboratory before cementation. The numbers in parentheses represent the number of missing responses to the different statements

	Rank mean
1. Poor margin adaptation	27.8 (5)
2. Inappropriate color	30.4 (2)
3. Unacceptable shape of crown	36.9 (4)
4. Inappropriate esthetic details	40.5 (5)
5. Interprox. contacts missing	53.3 (5)
6. Excess of ceramic material	64.6 (7)
7. Inappopriate occlusal form	69.3 (5)
8. Unacceptable ceramic glazing	78.4 (7)

DF = 7, H = 38.71, p = 0.00002.

Table 5. Rank order of the stated causes of need for improvement of metal–resin constructions in the dental laboratory before cementation. The numbers in parentheses represent the number of missing responses to the different statements

	Rank mean
1. Inappropriate color	24.8 (4)
2. Oversized facing	38.6 (7)
3. Unacceptable shape	46.8 (7)
4. Unacceptable esthetic details	56.2 (8)
5. Poor margin precision	57.8 (8)
6. Undersized facing	58.3 (8)
7. Porous veneer	60.4 (8)
8. Interprox. contact points missing	60.7 (8)
9. Resin material continuous between bridge units	65.9 (9)
10. Excess of veneer material	74.1 (11)
11. Inadequate surface finishing	76.9 (8)
12. Unacceptable occlusal shape	81.8 (7)
13. Inadequate gold protection	108.2 (7)

DF = 12, H = 44.56, p = 0.00005.

before cementation were inappropriate color and oversized facings (Table 5). As for metal–ceramic appliances a high percentage (65%) of the dentists stated that the veneer frequently was too light in metal–resin restorations.

The most frequently mentioned technical complications for metal–ceramic crowns over time were fractures of the facing and wear of the opposing teeth (Table 6). Of the nine dentists (52% of the sample) who answered the question, 66% found that such failures of the ceramic veneer equally frequently were located at the interface between the porcelain and the metal surface as in the body of the porcelain, whereas 36% estimated that fractures encompassing both levels were most common.

Most of the practitioners (65%) reported that they repaired fractured or damaged facings by a direct method by adding material to the existing veneer for both resin and ceramic material. A few dentists had recorded that they in such instances either remade the restoration or rebuilt the facing by an indirect method.

When the dentists were asked to rate patients' complaints about metal–resin crowns, wear and darkening of the facing

Table 6. Rank order of the stated complications with metal–ceramic constructions after cementation. The numbers in parentheses represent the number of missing responses to the different statements

	Rank mean
1. Fracture of facing material	14.5 (4)
2. Wear of opposing teeth	34.6 (3)
3. Loss of surface luster	44.2 (4)
4. Increased surface roughness	45.5 (4)
5. Discoloration	53.9 (7)
6. Wear of ceramic veneer	56.1 (7)
7. Change in color	57.2 (6)

DF = 6, H = 28.78, p = 0.002.

material were rated as the most commonly recognized negative comments (Table 7).

The intraoral conditions that seemed to influence most the practitioners' choice of a metal–resin or a metal–ceramic prosthetic restoration were the location in the mouth, the general periodontal condition of the recipient, and possible evidence of wear in the remaining dentition (Table 8). Whereas an anterior or a posterior location of the restoration in the arch appeared to have some influence on the selection of type of material (Table 9), no difference with regard to upper or lower jaw was detected. When evidence of wear in the remaining dentition was recognized, 53% of the dentists chose to insert a metal–resin crown, whereas 17% chose to use a metal–ceramic construction. Another 17% stated that they used either type of restoration in these cases, and 13% did not answer the question.

Table 7. Rank order of patients' complaints related to metal–resin constructions. The numbers in parentheses represent the number of missing responses to the different statements

	Rank mean
1. Wear of facing material	18.3 (1)
2. Darkening of the facing material	38.9 (3)
3. Yellowing of the facing material	40.4 (4)
4. Marginal discoloration of the facing	48.5 (2)
5. Graying of the facing material	48.9 (7)
6. Increased roughness of the facing surface	50.4 (7)

DF = 5, H = 21.15, p = 0.001.

Table 8. Rank order of the practitioners' reasons to select a metal–ceramic or a metal–resin construction. The numbers in parentheses represent the number of missing responses to the different statements

	Rank mean
1. The location of the restoration	37.5 (4)
2. The periodontal resistance of the patient	39.0 (5)
3. Evidence of wear in remaining dentition	39.3 (4)
4. The patient's wishes/demands	47.2 (3)
5. The age of the patient	55.3 (5)
6. The extent of the prosthetic treatment	56.3 (5)
7. The state of the remaining dentition	57.0 (4)
8. The cost of the treatment	78.8 (5)

DF = 7, H = 19.40, p = 0.001.

Nine of the practitioners claimed that the extent of restoration (number of bridge units) influenced their choice of technique type and that they would use a metal–resin appliance if the construction exceeded four units. Five of the respondents expressed that the extent of the restoration did not influence their selection, and three did not answer the question.

Discussion

The reported use of the metal–resin technique (45% of the cases) is in line with the results of a study by Valderhaug & Karlsen (4) in Norway. They claimed that metal–ceramic constructions partly replaced metal–

Table 9. The relation between the location of the restoration in the jaw arch and the choice between a metal–ceramic and a metal–resin restoration

	Front	Premolar	Molar
Metal–ceramic	58.8%	41.2%	0%
Metal–resin	0%	35.3%	58.8%
No answer	41.2%	23.5%	41.2%
Total	100%	100%	100%

resin crowns in the last year of their investigation. Furthermore, a recent survey of commercial dental laboratories in the Bergen area indicates a significantly lower percentage of these constructions compared with metal–ceramic crowns (19). According to the records for the products delivered from the dental laboratories during a 1-month period in 1987, the metal–resin technique was used in about 25% of the cases. Regardless of the possibility that the dentists may have overestimated their use of the metal–resin technique and underestimated the use of metal–ceramic constructions, the use of metal–resin constructions is considerable and in contrast with figures from the United States, which tend to show that the metal–resin technique virtually is not used (1).

With regard to the reasons for choosing one technique over the other, the favorable esthetic properties of porcelain were rated as the most important factor, in accordance with what is stated in the literature (9, 12, 13).

Fluorides in different applications are widely used in the Scandinavian countries. In spite of the known effects of fluorides on ceramic surfaces (20) this effect was not mentioned as a disadvantage by the participating dentists. On the other hand, the well-known difficulty related to the repair of porcelain facings, which reestablishes only a low percentage of the original strength (21, 22), was the main disadvantage mentioned. Likewise, the wear of opposing teeth by ceramic-covered appliances, which has been pointed out by several authors (17, 22), was also recognized by the dentists surveyed. The acceptable repair possibility of worn or fractured resin facings was rated as one of the main advantages of metal–resin constructions. Although the repair of prosthetic resin facings has not been extensively studied scientifically, figures from studies of denture base resins (23) and chemically and light-cured composite resin filling materials (24–27) indicate that joined resin material can obtain acceptable strength.

Almost two-thirds of the dentists claimed that they had observed a better marginal adaptation on metal–resin than on metal–ceramic constructions. Clinical studies of the two types of construction have demonstrated more extensive gingival retraction (12) and inflammation (13) in connection with subgingivally placed margins on metal–ceramic restorations. Studies that permit a direct comparison of the margin adaptation in vivo seem to be nonexistent, whereas long-term observations indicate more open margins on metal–ceramic crowns (5). Whether this is associated with distortion of the metal during porcelain firing (27) or is related to the different mechanical properties of the casting alloys and to the feasibility of burnishing and adjusting the margins (28) is not known. The fact that poor marginal adaptation was recorded as one of the main reasons for necessary amendment after the crown was received from the laboratory before it was ready for cementation points in this direction.

Another reason for correction was inappropriate color of the facing. Why the shade most frequently was too light is not known, but several explanations have been proposed (29). It is conceivable that the error is associated more with the shade selection than with the materials. Since the two facing materials did not differ in this respect, it is tempting to suggest that it has to do with a systematic error in shade selection or in the communication of the shade to the dental laboratory rather than with the materials per se.

For both types of crowns incorrect shape and oversized facing were frequent reasons for correction. Previous investigations have proposed that overcontouring of facings is a common problem, especially interproximally, on metal–ceramic facings (5, 30), and experience indicates that it is frequently a consequence of facial and proximal underreduction.

Fracture of the ceramic facing, which has been described to occur to a certain extent in metal-bonded ceramic restorations (5, 10), was the most frequently mentioned complication of such constructions (Table 6). Whereas cohesive fracture of the ceramic material has been described as that occurring most frequently (14), most dentists in the present survey claimed that they more often observed adhesive fractures at the interface

between the ceramic and the metal surface than exclusively in the porcelain. It is, however, realized that clinically it may be difficult to distinguish between the two types of fracture, since it appears that most failures are of a mixed nature. Most of the dentists chose to make a direct repair of such facings, even though repair of ceramic material is problematic and restores only partially the porcelain's original strength (21, 22). It has been suggested that rather than repair, the crown should be remade (22). It is more understandable that the practitioners used direct repairs to a large extent for resin facings in light of the more favorable strength of such repairs (23–25).

In line with reported esthetic changes on resin facings over time due to wear (3, 5, 10) and chemical instability of the materials (31), these constituted the patients' complaints. It should be noted that there were few such negative comments. Owing to the esthetic qualities of the facings it is hardly surprising that metal–ceramic constructions were frequently preferred in anterior regions of both jaws. Only half of the dentists said that they used metal–resin crowns in cases of considerable wear of opposing teeth despite the known fact that ceramic materials produce more wear both on natural teeth (22) and on other prosthetic materials (17). Thus, esthetic considerations seemed to overrule other concerns.

In cases of significantly reduced periodontal tissue, both the notion of a better marginal adaptation of metal–resin crowns and some technical considerations may play a part in the decision. Prosthetic reconstructions in dentitions with extensive reduction of periodontal tissue frequently mean large constructions with considerable technical difficulties. In this survey more than 50% of the practitioners claimed that they would use a metal–resin bridge if the restoration exceeded four units. This finding is in line with Swedish data on extensive bridgework made by general practitioners which indicate an overwhelming majority in favor of metal–resin constructions (3, 5).

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