Indirect restorations have been demonstrated to be effective, with clinical studies reporting a survival rate for single crowns of greater than 90% over 8-10 years, using current techniques.13,14 Luting agents, because they join indirect restorations to their preparations, are critical to their effectiveness.2 In addition to possessing the low solubility and high ultimate strength necessary for long-term retention of restorations, these materials must also maintain a minimal film thickness over a long enough interval that restorations can be seated completely.

Currently, 3 classes of luting agents, resin-modified glass ionomer, composite resin, and selfetching resin, are considered to be viable clinical options.2 In the past, composite resin cements demonstrated a greater film thickness than other cements,2,4 which is reflected in current ISO standards for dentine adhesion.3

The views expressed in the article are those of the author and do not reflect the official policy or position of the US Air Force, Department of Defense, or the US Government.

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Clinically Implications

As long as restorations are seated in a timely manner, all of the products evaluated in this study demonstrate acceptable film thicknesses.

Statement of problem. A luting cement must maintain a minimum film thickness over a sufficient period of time to allow seating of indirect restorations. The performance of newer luting cements in this regard has not been evaluated.

Purpose. The purpose of this study was to compare the film thicknesses of 6 luting cements, 2 resin-modified glass ionomer (FujiCEM and RelyX Luting Plus), 2 composite resin (Panavia 21 and RelyX ARC), and 2 self-adhesive resin (Maxcem and RelyX Unicem) cements, over 3 minutes.

Material and methods. The film thickness (µm) of each cement (n=7) was determined at room temperature at 1, 2, and 3 minutes after the start of mixing, according to the testing method set forth in ISO Standard 9917. Means of all materials tested meet the ISO test standard of 0.25-µm maximum film thickness for up to 2 minutes after mixing. (J Prosthet Dent 2009;101:189-192.)

Results. Except for 1 resin-modified material at 3 minutes, a point beyond its specified working time, all materials produced film thicknesses under 30 µm at 3 minutes and under 26 µm at 2 minutes.

Conclusions. All of the luting cements evaluated in this study meet the ISO standard of 0.25-µm maximum film thickness for up to 2 minutes after mixing. (J Prosthet Dent 2009;101:189-192.)

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MATERIAL AND METHODS

The 6 cements evaluated are listed in Table I. All were mixed according to manufacturers’ instructions (Table I), using supplied dispensers and/or automixing syringe tips when applicable. When required, hand mixing was performed for the recall polymerization after extrusion onto a sheet of coated paper. Measurement of film thickness entails pressing a cement mix under a defined load between 2 cylindrical pieces of glass with precisely parallel faces, known as optical flats. Subtraction of the thickness of the optical flats from the total yields film thickness of the cement. Film thickness was measured using methodology described in ISO Standard 9917.7 using a 150-N load except that instead of measuring at the manufacturer’s suggested working time, measurements were made at 1-, 2-, and 3-minute intervals after the start of mixing. This allowed a comparison of the cements at discrete time intervals and, indirectly, an estimate of comparative working times to be obtained.

Film thicknesses were determined using a micrometer accurate to ±1 µm (Absolute Digimatic, Model 331-711-10; Mitutoyo Corp, Kanagawa, Japan). For hand-mixed cements, the cement mix was applied to optical flats approximately 15 seconds prior to load application, whereas the automated cements were dispensed directly onto the bottom flat, with the top flat placed approximately 15 seconds prior to loading. Testing was performed at a room temperature of approximately 21°C, under fluorescent room lighting. Polymerization lights were not used.

With a power analysis, it was determined that a sample size of 7, at a significance level of 5%, and allowing a coefficient of variation of no more than 10%, would provide statistical power of 90%, assuming a 20% difference between the highest and lowest subgroups and equal spacing among the subgroups. Means of all cements were compared at the 2-minute interval, and means at the 1- and 3-minute intervals for each were compared to the mean for the same cement at 2 minutes, using 1-way analyses of variance (ANOVA) and Tukey-Kramer multiple comparison test (α = 0.05).

RESULTS

Each subgroup of data in this study was found to be normally distributed. Film thicknesses for all of the cements in the study were 25 µm or less through the 2-minute interval time only. Only the 2 resin-modified glass ionomer cements exceeded this value at the 3-minute interval, which was beyond the manufacturers’ specified working times for both. Even at the 3-minute interval, all of the resin-based cements produced film thicknesses of less than 27 µm. At the 2-minute interval, the mean film thickness for all of the cements ranged from 8.9 µm (FujiCEM) to 25.4 µm (RelyX Luting Plus), with considerable overlapping of the statistical groupings (Table II). Few significant differences were found when comparing film thicknesses for the 2-minute intervals to the thicknesses at the other time intervals for each cement. The 2 resin-modified glass ionomer cements were found to have significantly higher film thicknesses at 3 minutes than at 2 minutes. Complete results are presented in Table II, which includes manufacturers’ suggested working times. For all of the cements except the composite resin cement Panavia 21, these vary from 2 to 2.5 minutes and seem appropriate, relative to the film thicknesses measured. Panavia 21 has a suggested working time of 4 minutes, which may be appropriate, but which is beyond the intervals evaluated in this study.

DISCUSSION

Although there were 4 statistical groups among the 6 cements at the 2-minute interval, since all of the means were 25 µm or less, meeting the relevant ISO standard, the data do not support rejection of the null hypothesis that there is no difference in film thickness among the cements tested. None of the luting cements tested demonstrated a film thickness likely to interfere with seating of a restoration and do not appear to interfere with seating of a restoration or interfere with seating of a restoration, being an acceptably long period of time in the clinical setting.

It was the original intention of the authors to also evaluate cold mixing of the cements as a means of extending what were expected to be short working times, but preliminary testing showed that chilling of the cements had no influence on the film thickness or apparent rate of setting. Based on the results of this study, the authors consider testing at discrete time intervals a better method of comparing multiple cements than the ISO method of testing following the manufacturer’s recommended working time. It is probable that actual film thickness beneath indirect restorations may exceed the values obtained under the nearly ideal conditions in this in vitro study. It appears that composite resin cements meet the thinner 25-µm standard of water-based cements with relative ease, so it does not seem necessary for manufacturers to provide additional space for mixing, a period of time in the clinical setting. The authors believe the room-temperature
Affairs of the American Dental Association reported that several types of resin-modified glass ionomer luting cements meet the previously set standard when the load that simulates seating of a restoration is applied immediately after mixing. This report also used testing of film thickness as a rough test of working time, in that excessive film thickness indicated that the working time had elapsed. It was determined that most resin-modified glass ionomer cements possessed too great of a film thickness when tested at a point near the manufacturer’s specified working time limit. The purpose of this study was to determine the film thickness of representative resin-modified glass ionomer, composite resin, and self-adhesive resin luting cements. The null hypothesis was that there would be no differences in film thickness among the cements tested.

MATERIAL AND METHODS

The 6 cements evaluated are listed in Table I. All were mixed according to manufacturers’ instructions (Table I), using supplied dispensers and/or automixing syringe tips when applicable. When required, hand mixing was performed according to the manufacturer’s instructions after extrusion onto a sheet of coated paper. Measurement of film thickness entails pressing a cement mix under a defined load between 2 cylindrical pieces of glass with precisely parallel faces, known as optical flats. Subtraction of the thickness of the optical flats from the total yields film thickness of the cement. Film thickness was measured using methodology described in ISO Standard 9917 using a 150-N load, except that instead of measuring at the manufacturer’s suggested working time, measurements were made at 1-, 2-, and 3-minute intervals after the start of mixing. This allowed a comparison of the cements at discrete time intervals and, indirectly, an estimate of comparative working times to be obtained.

Film thicknesses were determined using a micrometer accurate to ±1 µm (Absolute Digimatic, Model 331-711-10; Mitutoyo Corp, Kanagawa, Japan). For hand-mixed cements, the cement mix was applied to optical flats approximately 15 seconds prior to load application, whereas the automated cements were dispensed directly onto the bottom flat, with the top flat placed approximately 15 seconds prior to loading. Testing was performed at a room temperature of approximately 21°C, under fluorescent room lighting. Polymerization lights were not used.

With a power analysis, it was determined that a sample size of 7, at a significance level of 5%, and assuming a coefficient of variation of no more than 10%, would provide statistical power of 90%, assuming a 20% difference between the highest and lowest subgroups and equal spacing among the subgroups. Means of all cements were compared at the 2-minute interval, and means at the 1- and 3-minute intervals for each were compared to the mean for the same cement at 2 minutes, using 1-way analyses of variance (ANOVA) and Tukey-Kramer multiple comparison test (P < .05).

RESULTS

Each subgroup of data in this study was found to be normally distributed. Film thicknesses for all of the cements in the study were 25 µm or less through the 2-minute time interval. Only the 2 resin-modified glass ionomer cements exceeded this value at the 3-minute interval, which was beyond the manufacturers’ specified working times for both. Even at the 3-minute interval, all of the resin-based cements produced film thicknesses of less than 27 µm. At the 2-minute interval, the mean film thickness for all of the cements ranged from 8.9 µm (FujiCem) to 25.4 µm (RelyX Luting Plus), with considerable overlapping of the statistical groupings (Table II). Few significant differences were found when comparing film thicknesses for the 2-minute intervals to the thicknesses at the other time intervals for each cement. The 2 resin-modified glass ionomer cements were found to have significantly higher film thicknesses at 3 minutes than at 2 minutes.

Means for time of 2 minutes with same letter not significantly different, 1-way ANOVA, Tukey-Kramer multiple comparison test (P < .05). Means for time of 2 minutes with same letter not significantly different, 1-way ANOVA, Tukey-Kramer multiple comparison test (P < .05).

DISCUSSION

Although there were 4 statistical groups among the 6 cements at the 2-minute interval, since all of the means were 25 µm or less, meeting the relevant ISO standard, the data do not support rejection of the null hypothesis that there is no difference in film thickness among the cements tested. None of the luting cements tested demonstrated a film thickness likely to interfere with seating of a restoration, 1-2 minutes after mixing, a long period of time in the clinical setting.

It was the original intention of the authors to also evaluate cold mixing of the cements as a means of extending what was expected to be short working times, but preliminary testing showed that chilling of the cements had no influence on the film thickness or apparent rate of setting. Based on the results of this study, the authors consider testing at discrete time intervals a better method of comparing multiple cements than the ISO method of testing following the manufacturer’s recommended working time. It is probable that actual film thicknesses are greater than those indicated by the ISO standard, the data not exceeded the values obtained under the nearly ideal conditions in this vitro study.

It appears that composite resin cements meet the thinner 25-µm standard of water-based cements with relative ease, so it does not seem necessary for clinicians to use the more expensive, more operator-intensive Class V resin cement space, which is usually done with die seating, at least when using the resin-based cements tested in this study. Although 3 of the 4 resin-based cements in the study were dual polymerized, the fluorescent room lighting does not appear to have adversely increased film thickness for these materials, so it is probably not necessary to shield this type of cement from ambient room lighting during mixing. The authors believe the room-temperature
values generated in this study to be clinically applicable, since luting cements reach body temperature only after setting time often extends several minutes after working time for luting materials, so occlusal loading by the cement has set.

It appears from this study that the resin-modified glass ionomer cement category is the most likely to produce incomplete seating of the restorations if placement is delayed, so clinicians using this type of luting cement should probably consider subdividing the cementation of a large number of restorations. It should be noted that setting time often extends several minutes after working time for luting materials, so occlusal loading by the cement has set.

Finally, it is the opinion of the authors that assessment based on film thickness may lead to an overestimation of working time, at least for resin-modified glass ionomer materials. It was associated obviously with reactivity and optimum adhesion to tooth structure, disappeared long before film thickness increased to unacceptable levels. In contrast to the previously cited report on film thickness in this study, no excessive film thicknesses were observed near the manufacturer’s stated working times. Despite this, the manufacturer’s working time should probably be considered the latest possible point for adequate seating of indirect restorations.

CONCLUSIONS

Within the limitations of this study, none of the luting cements evaluated had an excessive film thickness (greater than 25 µm) 2 minutes after the start of mixing, and all but a single resin-modified glass ionomer cement (ReliX Luting Plus) had average film thicknesses lower than 30 µm after 3 minutes.

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How should composite be layered to reduce shrinkage stress: Incremental or bulk filling?


Objectives: The purpose of this study was to determine the effect of different layering techniques on cuspal deflection in direct composite restorations.

Methods: Aluminum blocks were used to prepare MOD cavities divided into three groups. Each cavity was restored with composite using three different filling techniques. Group 1 was filled in bulk, group 2 was restored by a horizontal incremental technique, and group 3 by an oblique incremental technique. Cuspal deflection was measured with LVDT probes and compared among groups using ANOVA and Scheffe’s post hoc test (α = 0.05).

Results: The cuspal deflections in groups 1–3 were 21.6 ± 0.90 µm, 19.3 ± 0.73 µm and 18.4 ± 0.63 µm, respectively. The bulk filling technique yielded significantly more cuspal deflection than the incremental filling techniques, while there was no significant difference between the horizontal and oblique incremental methods.

Significance: Cuspal deflection resulting from polymerization shrinkage can be reduced by incremental filling techniques to obtain optimal outcomes in clinical situations.

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Reliability and accuracy of four dental shade-matching devices

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Statement of problem. There are several electronic shade-matching instruments available for clinical use, but the reliability and accuracy of these instruments have not been thoroughly investigated.

Purpose. The purpose of this in vitro study was to evaluate the reliability and accuracy of 4 dental shade-matching instruments in a standardized environment.

Material and methods. Four shade-matching devices were tested: SpectroShade, ShadeVision, VITA Easyyshade, and ShadeScan. Color measurements were made of 3 commercial shade guides (Vitapan Classical, Vitapan 3D-Master, and Chromacom). Shade tabs were placed in the middle of a gingival matrix (Shofu GUMY) with shade tabs of the same nominal shade from additional shade guides placed on both sides. Measurements were made of the central region of the shade tab positioned inside a black box. For the reliability assessment, each shade tab from each of the 3 shade guide types was measured 10 times. For the accuracy assessment, each shade tab from 10 guides of each of the 3 types evaluated was measured once. Differences in reliability and accuracy were evaluated using the Standard Normal z test (2 sided) (α = 0.05) with Bonferroni correction.

Results. Reliability of devices was as follows: ShadeVision, 99.0%; SpectroShade, 96.9%; VITA Easyyshade, 96.4%; and ShadeScan, 87.4%. A significant difference in reliability was found between ShadeVision and ShadeScan (P < .008). All other comparisons showed similar reliability. Accuracy of devices was as follows: VITA Easyyshade, 92.6%; ShadeVision, 84.8%; SpectroShade, 80.2%; and ShadeScan, 66.8%. Significant differences in accuracy were found between all device pairs (P < .001) for all comparisons except for SpectroShade versus ShadeVision (P > .032).

Conclusions. Most devices had similar high reliability (over 96%), indicating predictable shade values from repeated measurements. However, there was more variability in accuracy among devices (67-93%), and differences in accuracy were seen with most device comparisons. (J Prosthet Dent 2009;101:193-199)