Clinical Success of Zirconium Oxide Posts with Resin Composite or Glass-Ceramic Cores in Endodontically Treated Teeth: A 4-Year Retrospective Study

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Purpose: This study retrospectively evaluated zirconium oxide posts with either direct resin composite cores or indirect glass-ceramic cores after several years of clinical service. ***Materials and Methods:*** One hundred forty-five endodontically treated teeth in 88 patients were restored with zirconium oxide posts; 87 teeth were restored with direct composite cores, and 58 were restored with Empress cores prior to crowning. Seventy-nine posts with direct composite cores in 52 patients and 34 posts with glass-ceramic cores in 19 patients were reevaluated clinically and radiographically after a mean clinical service of 57.7 months and 46.3 months, respectively. ***Results:*** Periodontal probing depths remained on a healthy clinical level, and esthetics were judged excellent for the majority of teeth in both groups. In the group with direct composite cores, no failures were observed in the 79 posts that were reevaluated. In the group with indirect glass-ceramic cores, three failures were observed after 42, 43, and 55 months of clinical service. All failures were due to loss of retention. In a best-case scenario posts that could not be reevaluated were considered successful, and in a worst-case scenario they were considered failures; respective success rates were 100% and 91% in the direct group and 95% and 53% in the indirect group. ***Conclusion:*** The observed clinical success of zirconium oxide posts with direct composite cores suggests that this method of post-and-core reconstruction is clinically promising. Zirconium oxide posts with indirect glass-ceramic cores displayed a significantly higher failure rate and a high dropout rate that precludes valid conclusions. *Int J Prosthodont 2004;17:524–528.*

Following successful endodontic treatment of extensively damaged teeth that require crown therapy, a metal post is fabricated, combined with a variety of core materials (eg, cast gold, amalgam, resin composite). The objective is to increase retention for the core material and distribute occlusal stresses along the remaining interface with the tooth structure.[1–3] Current recommendations for post placement suggest minimal removal of existing tooth substance, placement of a post only if more than 50% of the tooth substance is lost, use of the narrowest post diameter possible, and avoiding placement of cantilevered prostheses on such abutment teeth.[4–7]

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The increasing use of high-translucency ceramics for fixed prosthodontics suggests that light-conducting nonmetal post systems could be considered to prevent a grayish appearance of the marginal gingiva because of the unfavorable nature of light reflection when a dark post is present. Glass fiber–reinforced resin composite posts and ceramic posts are alternative options if esthetic qualities are required of the post system, with single-appointment direct buildup cores being the most popular. Alternatively, ceramic posts can be combined with a ceramic core in an indirect procedure.

The purpose of this retrospective study was to: *(1)* evaluate the treatment outcome of ceramic posts with either direct resin composite or indirect ceramic core buildup after several years of clinical service; and *(2)* compare clinical and radiographic long-term results of such posts with historically available long-term data on metal posts.

Materials and Methods

In January 2001, all patient charts of the Department of Fixed Prosthodontics, University of Zurich Dental School, Switzerland, were screened for patients with teeth that had received post-and-core treatment using zirconium oxide posts. Endodontic treatment on these teeth had usually been carried out either at the Dental School or by private practitioners. Eighty-eight patients with 145 endodontically treated teeth (incisors, canines, or premolars) had received such treatment between July 1993 and May 2000.

Eighty-seven teeth were restored with direct composite cores, and 58 were restored with Empress cores (Ivoclar Vivadent) prior to crowning. All posts were of cylindroconical shape and made of tetragonal zirconia polycrystals (ZrO_2-TZP) stabilized by 3 mol% Y_2O_3 (experimental posts, Federal Institute of Technology, Zurich; Cosmopost, Ivoclar Vivadent). Post length was adapted to support the core buildup along its full height after post cementation by cutting with a diamond bur using copious irrigation. Radiographs were taken after post insertion. Post placement was carried out by clinicians in the Department of Fixed Prosthodontics, University of Zurich Dental School. All posts were sandblasted, then bonded into root canals using a self-curing resin composite cement (Panavia 21 TC, Kuraray) after dentin conditioning with the primer of a dentin bonding agent (AllBond 2, Bisco; or ART Bond, Coltène-Whaledent).

In the direct group, core buildups were directly bonded to the post by using either a self-curing or light-curing resin composite (Core Paste, DenMat; or Tetric, Ivoclar Vivadent). After crown preparation (circular shoulder margin) and impression taking, abutments were protected with a provisional restoration until final cementation of a porcelain-fused-to-metal or ceramic crown (Empress).

In the indirect group, posts were fitted into the root canal and Empress cores were pressed on the zirconia post with either a direct or an indirect technique. For the direct technique, a self-curing methacrylate (Pattern Resin, GC) was used to model a buildup directly onto the post. Using the lost-wax-pattern technique, a glass-ceramic core was heat pressed onto the post. For the indirect technique, an impression was taken after post fitting. On a master model, a core was subsequently modeled in wax onto the post prior to heat pressing the glass-ceramic core. Posts with Empress cores were sandblasted and bonded into root canals after dentin conditioning with a dentin bonding agent (Syntac Classic, Ivoclar Vivadent) using a dual-cure resin composite cement (Variolink, Ivoclar Vivadent). Abutments were provisionalized as in the other group until delivery of a final crown.

Between April 2001 and January 2002, 113 of the 145 teeth that had received post treatment could be reevaluated in 71 patients. In the group with direct composite cores, 79 posts could be reevaluated clinically and radiographically in 18 male and 34 female patients. The age ranges of these patients were 17 to 75 years for males (mean 41.7 years) and 21 to 81 years for females (mean 43.1 years). In the group with Empress cores, 34 posts could be reevaluated clinically and radiographically in 8 male and 11 female patients. The age ranges of these patients were 40 to 76 years for males (mean 57.3 years) and 35 to 81 years for females (mean 60.8 years).

Selected clinical parameters were measured (probing depth, mobility, gingival and dental color match, occlusion, photographic documentation), and periapical radiographs of each tooth were taken. Probing depth and mobility were measured in an effort to monitor periodontal health (index according to Nyman and Lindhe[8]). Gingival and dental color match was assessed according to US Public Health Service (USPHS) criteria to evaluate esthetic appearance.[9] The nature of occlusal contact was evaluated to assess the presence of functional overload (anterior guidance, posterior disclusion during excursion). Six patients with a total of 8 posts in the group with direct composite cores and 11 patients with 24 posts in the group with Empress cores could not be reevaluated because the patients could not be located.

For statistical analysis of the retrospective data, a tooth treated with a post and core was defined as a "success" if the post and core and the crown were still in place and did not show any signs of clinical or radiographic complications. A "failure" was defined as a post and core that was no longer in place. Analyzed parameters for both groups were gender (using a chi-square test expressed by a corrected Fisher's exact *P* value), age (using a Mann-Whitney test), and cumulative survival (for both groups expressed as a Kaplan-Meier plot for best- and worst-case scenarios).

Results

Seventy-nine posts could be reevaluated in the group with direct composite buildups; in this group, 33 patients received 1 post, 14 patients received 2 posts, and 6 patients received 3 posts. In the group with indirect Empress cores, 34 posts could be reevaluated; in this group, 11 patients received 1 post, 4 patients received 2 posts, 2 patients received 3 posts, and 1 patient each received 4 and 5 posts.

In the direct group (Fig 1), all 79 posts examined were still in clinical use. Observation times varied between 14 and 118 months (mean 57.7 months). No failures were observed for the reevaluated posts. Eight

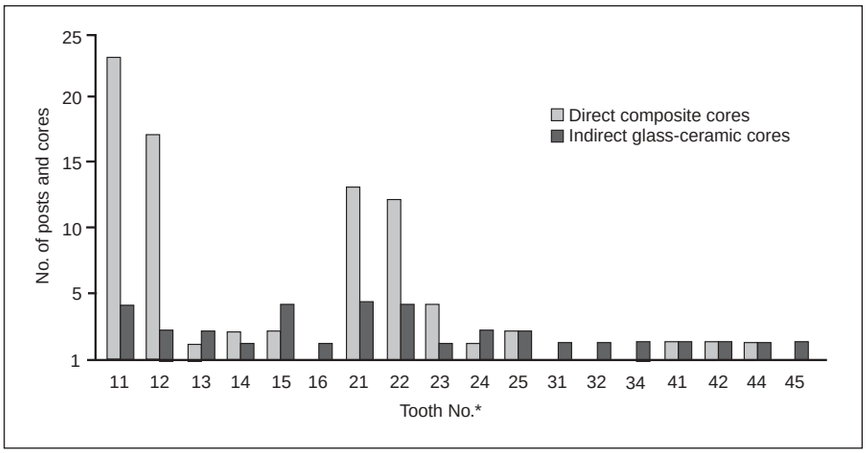

Fig 1 Distribution of reexamined restorations. *Fédération Dentaire Internationale tooth-numbering system.

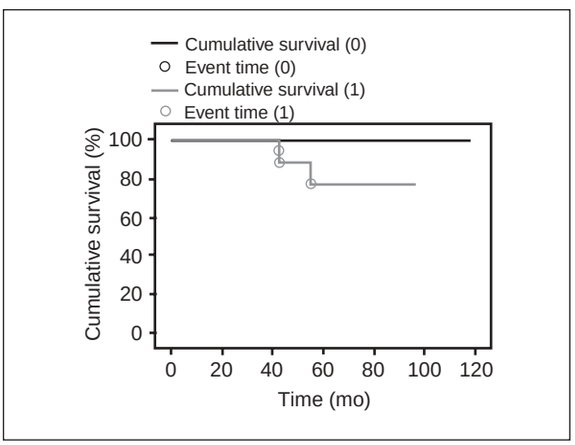

Fig 2 Cumulative Kaplan-Meier survival rate of posts calculated using best-case scenario (missing posts considered successful).

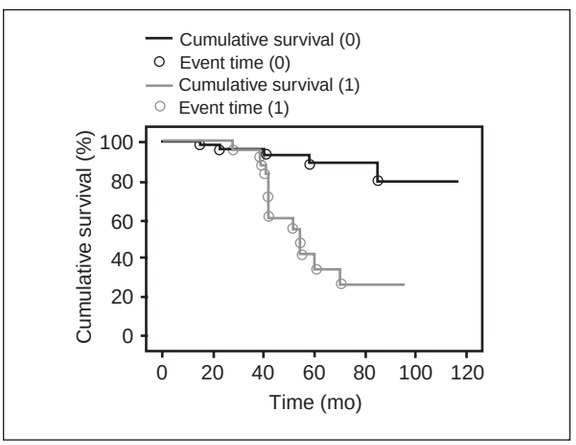

Fig 3 Cumulative Kaplan-Meier survival rate of posts calculated using worst-case scenario (missing posts considered failures).

posts could not be reevaluated in six patients. These data correspond to a success rate of 100% for a best-case scenario, in which the eight missing posts are also considered successful (Fig 2). In a worst-case scenario (the eight missing restorations are considered failures), the success rate would be 91% for this group (Fig 3).

In the indirect group (Fig 1), 31 posts of the 34 that were examined were still in clinical use. Observation times varied between 14 and 97 months (mean 46.3 months). Three failures were observed for the reevaluated posts because of loss of retention. Twenty-four posts could not be reevaluated in 11 patients. In a best-case scenario, in which all 24 missing restorations are considered successful, these data correspond to a success rate of 95% (Fig 2). However, the success rate in this group drops to 53% if the 24 missing restorations are considered failures (Fig 3).

Probing depths were generally $\leqslant$ 4 mm for all teeth examined. Tooth mobility was generally $\leqslant$ 0.5 (index according to Nyman and Lindhe[8]). Color match with neighboring teeth was mainly rated alpha (n = 67) or beta (n = 12) in the direct group as well as the indirect group (n = 29 and n = 5, respectively). Color match of the vestibular marginal gingiva of post-treated teeth with vital neighboring teeth was mainly rated alpha (n = 64) or beta (n = 15) in the direct group as well as the indirect group (n = 26 and n = 8, respectively). Occlusion was generally rated uneventful (anterior guidance, posterior disclusion during excursion). Two cases in the direct group and one case in the indirect group showed minor laterotrusive

contacts during excursion that were subsequently eliminated.

For both groups of missing restorations (6 patients with 8 posts in the direct group and 11 patients with 24 posts in the indirect group), gender and age were nonspecific parameters compared to the groups that could be evaluated.

The three failures observed in the indirect group because of loss of retention were found in a maxillary central incisor, a maxillary lateral incisor, and a mandibular second premolar after 42, 43, and 53 months of clinical service, respectively.

Discussion

A meta analysis[10] of clinical long-term studies of titanium posts that were mainly combined with resin composite buildups revealed a success rate of 81% after 6 years.[11] Success rates of 89% to 93% are also reported for metal posts with cast or direct cores after 3 to 8 years of observation.[12–14] A recent study reveals clinical service success rates of 92% to 100% for metal posts with cast-gold cores after 8.6 years, and 80% for metal posts with direct composite cores after 5.5 years.[15]

In the current study, periodontal probing depths remained on a healthy clinical level for all teeth examined, and esthetic appearance was judged as excellent for the majority of teeth in both groups. This judgment was based on the pale pink color of the marginal gingiva found in neighboring vital teeth. The unnatural grayish appearance of the marginal gingiva often found in teeth treated with metal posts was not detected in any of the evaluated post-treated teeth.

The success rate of zirconia posts with direct composite buildups (best case 100% after a mean of 4.8 years) exceeded that of zirconia posts with indirect glass-ceramic buildups (best case 95% after a mean of 3.9 years), particularly for the worst-case scenarios (91% vs 53%). However, the low success rate in the indirect group based on the worst-case scenario may be misleading because of the high dropout rate that precludes definitive conclusions.

The three failures in the indirect group were exclusively caused by loss of retention. Neither geometry nor width of the root canals showed any difference from teeth in the direct group. None of the failed posts had fractured, suggesting that the technique sensitivity of the adhesive cementation procedure, rather than material properties of the post and core itself, was the responsible parameter. A dual-cure luting resin combined with a dentin bonding agent were used for cementation of the failed posts; this appeared to be the most likely cause of the increased failure rate.

The worst-case scenarios expressed above were calculated for all reevaluated posts against missing posts. Because several patients received more than one post, we also calculated success rates for the worst-case scenarios if only one post per patient was randomly considered. The rates became 90% for the posts with composite buildups (instead of 91%) and 63% for the posts with Empress cores (instead of 53%). An additional argument for the direct technique, apart from the statistical results, is the time saved during the single-appointment procedure compared to the indirect technique.

While a large number of patients from the indirect group were not followed up, statistical analysis within both groups of missing patients (direct and indirect groups) revealed that gender and age were similarly represented in the reevaluated groups of patients, suggesting that these two parameters were not specific.

The properties of the employed post and the core material have elicited divergent opinions. Some authors advocate a modulus of elasticity for posts similar to that of dentin,[16–18] whereas others believe that a high-stiffness post provides greater longevity.[19,20] Both theories remain untested in clinical trials. Among direct-placement materials, amalgam scores well in strength, stiffness, and dimensional stability. However, amalgam also has significant disadvantages, such as discoloration of tooth structure from corrosion products, that preclude its use in anterior teeth. Resin composites, in contrast, have high flexural strength, while glass-ceramics are more suitable for buildups in the anterior dentition.[21]

Conclusion

Within the limitations of the research design employed, zirconium oxide posts combined with direct composite cores demonstrated excellent clinical success after a mean of 57.5 months of clinical service. This suggests that these restorations may be a valid alternative to other traditional approaches, particularly in the anterior dentition. The survey of zirconium oxide posts combined with glass-ceramic cores also demonstrated good success after 46.3 months of clinical service, with only three failures. However, a high dropout rate for this patient group precluded valid conclusions.

Acknowledgments

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Literature Abstract

Postoperative irradiation with or without concomitant chemotherapy for locally advanced head and neck cancer

In this multicenter trial, 334 previously untreated patients with histologically proven stage III or IV non-metastatic squamous-cell carcinoma arising from the oral cavity, oropharynx, hypopharynx, or larynx, were randomly assigned to receive radiotherapy alone or radiotherapy combined with chemotherapy. All patients underwent primary surgery performed with curative intent followed by 66 Gy of radiation in conventionally fractionated doses of 2 Gy in five weekly sessions over 6 weeks. One hundred sixty-seven of the 334 patients were randomly selected to receive 100 mg of cisplatin per square meter of body surface area on days 1, 22, and 43 of the radiotherapy regimen. The combined therapy group experienced significantly greater incidence of severe functional mucosal adverse effects (incidence 41% versus 21%). After a median follow-up of 60 months, the estimated median duration of disease-free survival was 23 months for the radiotherapy group and 55 months for the combined therapy group. A total of 174 patients died during the study (52%). The estimated median time to death for the radiotherapy group was 32 months and 72 months for the combined group. A Kaplan-Meier estimate of overall survival at 5 years was 40% in the radiotherapy group and 53% in the combined group. The authors concluded that the addition of chemotherapy to radiotherapy significantly increased the rates of local control, disease-specific survival, and overall survival without the incidence of late adverse effects. .

Bernier J, et al. *N Engl J Med* 2004;350:1945–1952. **References:** 34. **Reprints:** Dr J. Bernier, Department of Radio-Oncology, San Giovanni Hospital, Oncology Institute of Southern Switzerland, CH-6504 Bellinzona, Switzerland. e-mail: jacques.bernier@hcuge.ch—*Donald A. Somerville, Toronto, Canada*