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CLINICAL SCIENCE

Clinical outcomes and success rates of quartz fiber post restorations: A retrospective study

Candida Parisi, DDS,[a] Luiz F. Valandro, DDS,[b] Leonardo Ciocca, DDS,[c] Maria R. A. Gatto,[d] and Paolo Baldissara, DDS[e]

ABSTRACT

Statement of problem. Cast metal posts and dowels are inherently dark and, when metal-free restorations are used, could impair the definitive esthetic appearance. Quartz fiber posts could represent a reliable choice for restoring abutment teeth.

Purpose. The purpose of this study was to evaluate the long-term success rate of teeth restored with quartz fiber posts and fixed dental prostheses (FDPs).

Material and methods. Ninety-nine teeth restored with 114 quartz fiber posts and FDPs were evaluated. The evaluation time ranged from 7 months to 9.25 years. The Kaplan-Meier method was used to obtain success curves. The influence of the tooth location, definitive restoration, and failure pattern upon the success function was analyzed with the log-rank test. The Cox regression test was used to evaluate possible predictors among the interactions of the observed parameters.

Results. The success rate of the restorations was 85.86% in a mean period of 5.88 ±1.37 years, with an estimated success probability of 85% at 6.17 years. The statistical analysis identified the factors related to the arch (P=.045) and type of definitive restoration (P=.021) as significantly associated with success. Post debonding was the most frequent failure mode, followed by endodontic failure, with the latter not necessarily being related to the post itself. No root fractures were recorded. Twelve teeth out of the 14 that failed were restored again, bringing the overall survival rate of the teeth to 98%.

Conclusions. The rehabilitation of abutment teeth with quartz fiber posts can be considered a reliable procedure; however, adhesive techniques and luting materials require improvement. (J Prosthet Dent 2015;114:367-372)

The increasing demand for esthetics in restorative and prosthetic dentistry has limited the use of metal or opaque restorations; metal endodontic posts are being replaced with clear or white-colored fiber posts to better match translucent composite resins and ceramic materials. Quartz or pure silica fiber posts are clear, are transparent to visible light, and have high flexure strength.[1,2] Furthermore, the elastic modulus of quartz fiber posts is low (49 GPa) compared with carbon, metal, or ceramic ones (110 to 200 GPa).[3] The lower elastic modulus reduces stress concentration on the root dentin and the percentage of unrecoverable failures due to root fracture.[4-8]

Adhesive bonding techniques, treatments of the post surface, and application of precise guidelines have allowed fiber posts to compete with the conventional cast metal posts and dowels in the restoration of endodontically treated teeth.[9] Longitudinal studies[10,11] suggest that the lower elastic modulus reduces the cause of failure by root fracture but increases the debonding of the restoration interfaces and subsequent bacterial microleakage.[12-14] Such failures and the caries that follow could be related to the low elastic modulus

[a]Tutor, Department of Biomedical Sciences and neuromotor (DIBINEM), School of Dentistry, Unit of Odontostomatological Sciences, Division of Prosthodontics, Alma Mater Studiorum, University of Bologna, Bologna, Italy.
[b]Professor, Faculty of Dentistry, Federal University of Santa Maria, Rio Grande do Sul, Brazil.
[c]Researcher, Department of Biomedical Sciences and neuromotor (DIBINEM), School of Dentistry, Unit of Odontostomatological Sciences - Division of Prosthodontics, Alma Mater Studiorum, University of Bologna, Bologna, Italy.
[d]Aggregate Professor, Medical Statistics Course, Department of Biomedical Sciences and neuromotor (DIBINEM), Unit of Odontostomatological Sciences, Division of Orthodontics and Gnathology, Alma Mater Studiorum, University of Bologna, Bologna, Italy.
[e]Aggregate Professor, Dental Materials Course; Department of Biomedical Sciences and neuromotor (DIBINEM), Unit of Odontostomatological Sciences, Division of Prosthodontics, Alma Mater Studiorum, University of Bologna, Bologna, Italy.

Clinical Implications

Quartz fiber light-conductive posts are advantageous in metal-free restorations because they do not interfere with the definitive esthetic appearance and allow greater polymerizing light transfer to the luting material and adhesive.

of certain fiber post brands, particularly those made of E-glass fibers.[15-18] However, debonding is the most frequent failure reported for fiber post restorations.[10,12,13,19-23]

The cement type and cementation techniques adopted to create a bond between the post and the tooth structure are considered significant factors in determining the long-term success of endodontically treated teeth.[24,25] Resin cements are reported to provide adequate post-dentin bond strength, which may be increased when self-adhesive resin cements are used.[26,27]

Despite the increasing use of clear-colored and light-conductive fiber posts, few longitudinal studies of this type of restoration have been performed, particularly over the medium and long term.[19-21,28-30] Ferrari et al[19] analyzed different types of carbon and quartz fiber posts and demonstrated a low failure rate of 3.2% at 6 years, with no failures due to root fracture. Studies on glass fiber posts reported a failure rate of 12.8% at 2 years, 20.1% at 5 years, and 32.5% at 6.5 years.[22,23,31]

The purpose of this study was to evaluate the success rate of endodontically treated teeth restored with translucent light-conductive quartz fiber posts within a period of 7 months to 9.25 years. The influence of tooth location, type of definitive restoration, and failure pattern on survival rate were also evaluated. The null hypothesis was that the success rate would be independent of these parameters.

MATERIAL AND METHODS

In this retrospective cohort study, all the patients who received at least 1 quartz fiber post (Light-Post; RTD) from one of the authors (P.B.) were contacted for a clinical recall. Sixty-one patients responded and signed an informed consent form in accordance with the guidelines for clinical research in the declaration of Helsinki. A total of 99 teeth, 29 anteriors (incisors and canines) and 70 posteriors (premolars and molars), received 114 quartz fiber posts. The restorations were performed following the clinical procedures recommended by the post manufacturer (RTD), observing the guidelines reported by Peroz et al[32] with regard to the amount of coronal tooth structure, canal enlargement, and ferrule height of the definitive preparation.[33]

Generally, teeth having 1 or no residual wall always received a post, whereas teeth having 2 to 4 residual walls received the post only if the wall thickness was less than 1 mm.[9] The root canals were not enlarged to avoid root weakening. The coronal preparations were carried out to obtain a ferrule height of at least 1.5 mm on the whole circumference of the tooth. Each root received endodontic treatment, and the canals were sealed using the vertical condensation technique.[34]

Within 7 to 14 days after the endodontic treatment, the posts were inserted with rubber dam isolation. The canals were prepared with preshaping drills of the appropriate size (RTD) for the removal of gutta percha, maintaining an apical seal of at least 3 to 4 mm.[35-37] Subsequently, the root canal was only slightly shaped with the finishing drills (RTD) in accordance with the minimal intervention guidelines,[38] and the post corresponding to the drill used was chosen. The tooth was etched for 15 seconds with 32% phosphoric acid (Uni-Etch; Bisco Inc), washed with water spray, and dried with paper points. Finally, the post was cemented with a bonding system (All-Bond 2; Bisco Inc), a resin cement (C&B selfpolymerizing resin cement; Bisco Inc); and a composite resin (BisCore; Bisco, Inc) was used for core restoration. As a definitive restoration, the teeth received single crowns[39] or fixed dental prostheses (FDPs). The prostheses were cemented with glass ionomer cement (Fuji Plus; GC Corp), following the manufacturer's instructions.

The restoration was defined as successful if it satisfied the following conditions detected with an intraoral radiographic examination, mirror, explorer, and periodontal probe[40]: absence of subjective or persistent complaints (pain, foreign body sensation, and/or dysesthesia); no radiolucency around the root; no bone defects radiographically detected; absence of marginal openings at the tooth/restoration interfaces; no debonding of the restoration; no root, post, or restoration fracture; and no secondary caries. On the basis of these criteria, the survival statistics described relate to the success of the restorations.[41,42]

The date of the post placement was considered as the baseline for computing the restoration endurance. A restoration was deemed failed when at least 1 of the aforementioned clinical conditions occurred, necessitating tooth repair or extraction. The teeth were declared as survived when the restorations were successful or, although failed, a new restoration was placed to replace the failed one. The time to failure or the last recall to which the restoration was successful was recorded in months, rounded down to the nearest month. One experienced operator (C.P.), other than the one who prepared the restorations, performed the clinical and radiographic evaluation.

Success curves and statistical comparisons were calculated considering the tooth location in the maxillary or mandibular arch and in the anterior or posterior position in the arch, type of definitive restoration (single crowns, multiunit FDPs, or partial removable dental prosthesis abutment [PRDPA] crowns), and failure patterns.

The statistical analysis was performed using the success proportions obtained (14%), and a sample size was calculated a posteriori. By evaluating the success proportions of the previous studies reported in Table 1, a reference value of 7% was considered appropriate. A maximum permitted difference for considering the percentage equivalent to the known was estimated as 20%. In these conditions, a minimum sample size of 93 teeth was calculated with a power of 90% (α=.01).[43] Frequency distributions were used to describe categorical data, which were compared with the chi-square test. Data were summarized with median and interquartile range, proportion, and 95% confidence intervals. Success functions of the restorations were estimated nonparametrically according to the Kaplan-Meier method. The log-rank test was used to analyze the influence of tooth location (maxillary or mandibular arch, anterior or posterior position in the arch), type of definitive restoration, and failure pattern upon the success function. Cox-regression, accomplished using the backward method, was then performed to identify the possible predictors among the interactions of the observed parameters. A level of significance of α=.05 was adopted.

RESULTS

At the clinical and radiographic examinations, 14 (14.14%) failures out of the 99 treated teeth were recorded, 12 of which occurred between 21 and 74 months after the post's insertion. The other 2 failures occurred at 7 and at 96 months. Twelve failed teeth were recovered and restored again; the 2 remaining failed teeth, both initially restored with single crowns, were extracted because of nonrestorable root dentin caries. The Kaplan-Meier survival (success) curve showed that an estimated 85% of the teeth restored with quartz fiber posts were successful after a period of 74 months (95% CI, 0.772-0.928) (Fig. 1). The estimated median success time was 72 months (success rate 0.475 ±0.05; 95% CI, 0.376-0.573). The estimated median success time of the 14 failed teeth was 52 months (interquartile range: 25-64 months). The average annual failure rate was 2 ±1%. Tables 2, 3 summarize the recorded failures and statistical results according to the tooth location (maxillary or mandibular arch and anterior or posterior position in the arch), type of definitive restoration, and failure patterns.

Comparing success probabilities as a function of the location in the maxillary or mandibular arch, a statistically significant difference was found (P=.045): the teeth positioned in the mandibular arch showed a success of 94.7% after 64 months compared with 83.7% for the teeth in the maxillary arch after the same period. No significant differences (P=1.000) were observed when investigating the success rate as a function of the position in the arch: the teeth positioned in the anterior arch presented a success probability of 85.8% after 60 months compared with 89.7% for teeth positioned in the posterior arch after the same period. Comparing the type of definitive restoration, the estimated success function presented a statistically significant difference with regard to PRDPA (P=.021). The success probability after 64 months was 88% for a single crown, 94.8% for multiunit FDPs, and only 50% for PRDPA. Teeth restored with

Table 1. Longitudinal studies reporting follow-up time and failure rates of quartz fiber posts

Author	Follow-up Time (y)	No. of Teeth	Failure Occurrence	Post Fiber Material
Ferrari et al[19]	6	1304	3.2%	Quartz, carbon, and hybrids
Malferrari et al[28]	2.5	180	1.7%	Quartz
Monticelli et al[20]	2.7	225	6.2%	Quartz, glass
Ferrari et al[29]	7	985	7-11% 7% Quartz	Quartz, carbon, and hybrids
Ghavamnasiri et al[30]	1-6	43	51.2%	Quartz
Cagidiaco et al[21]	2	162	7.3%	Quartz

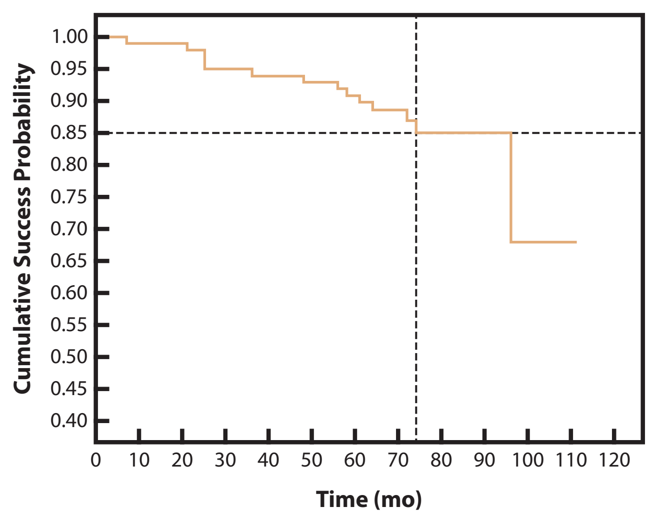

Figure 1. Kaplan-Meier success curve at 74 months (6.17 years) estimated 85% of teeth restored with quartz fiber posts were successful (95% confidence interval: 0.772-0.928).

Table 2. Failure distribution of teeth restored with quartz fiber posts according to their location (n = number of teeth)

Variable	Anteriors	%	Posteriors	%	Total Failures	%
Maxillary arch	4 (n=28)	14.3	8 (n=29)	27.6	12 (n=57)	21.0
Mandibular arch	0 (n=1)	0	2 (n=41)	4.9	2 (n=42)	4,8
Total failures	4 (n=29)	13.8	10 (n=70)	14.3	14 (n=99)	14.1

Table 3. Descriptive parameters and statistical comparisons, (α=.05)

Description	No. of Restored Teeth	Failures (relative %)	P
Arch			
Maxillary	57	12 (21.1)	.045
Mandibular	42	2 (4.8)	
Tooth position in the arch			
Anterior (incisors/canines)	29	4 (13.8)	1.000
Posterior (premolars/molars)	70	10 (14.3)	
Restoration type			
Single crowns	54	8 (14.8)	.021
Multiunit fixed dental prostheses	39	3 (7.7)	
Partial removable dental prosthesis abutment	6	3 (50)	
Failure pattern			
Debonding	9	(64.3)	.001
Secondary caries	2	(14.3)	
Endodontic lesion	3	(21.4)	

single crowns showed a significantly higher (P=.021) failure rate than teeth restored with multiunit FDPs: 14.8% vs 7.7%, (Table 3). Of the 8 single crown failures, 3 failed because of the presence of a periapical lesion, 1 because of secondary caries, and 4 because of debonding of the post. A statistically significant difference (P=.001) was observed for the failure pattern (endodontic lesion, secondary caries, debonding): considering the 2 most frequent modalities, after 64 months the probability of endodontic failures was 67% and debonding was 89%. Cox regression evidenced no significant predictors among the single parameters, but some significant interactions were observed. The strongest interaction involved arch (maxillary or mandibular) and position in the arch (anterior or posterior) (Exp(B)=1.896, P=.018). It denoted a significant association between failures and posterior teeth of the maxillary arch with an increase of 89.6% in the possibility of failure for this tooth location.

DISCUSSION

The failures were evaluated with respect to several parameters: arch, (maxillary or mandibular), position in the arch (anterior or posterior), type of definitive restoration, and mode of failure. The null hypothesis that the success rate of quartz fiber post restorations is independent of these parameters was rejected. The statistical analysis identified the interaction of the factors related to "arch" and "position in the arch" with the success rate. The teeth in the maxillary arch showed a statistically higher failure rate than those in the mandibular arch. These data are in agreement with a study on different fiber post types,[29] which also showed increased maxillary failure rates and increased maxillary failures in the posterior teeth. The latter finding was also confirmed in the present study: among the 12 failures in

Figure 2. Restoration failure on maxillary right canine and lateral incisor with debonding of partial removable dental prosthesis abutments crown, microleakage, and secondary caries. Both teeth were successfully restored again.

the maxillary arch, more failures occurred in the posterior than the anterior teeth, at a ratio of 2 to 1 (Table 2). In a previous retrospective study,[30] the dental arch was found to be a significant predictive factor of failure, with teeth in the maxillary arch having a higher failure rate than teeth in the mandibular arch, as in the present study.

Conflicting observations have been reported, with some studies showing a greater percentage of failures in the anterior sector than the posterior,[23,31] while others have reported the opposite.[29,39] Theoretically, a higher incidence of failures in the anterior teeth can be explained by the different forces acting on them. The anterior elements are subject to moment forces greater than those acting on the posterior teeth, where masticatory loads more often generate compression stresses; fatigue fractures are predominantly caused by tensile stress, seldom by compression.[23,41] However, the greater failure rate of posterior restorations has been related to the increased difficulties that arise during endodontic treatment and post placement in multirooted teeth.[24,31] The high occurrence of the fiber post debonding recorded in this study agrees with the findings reported in previous studies.[24,31]

Single crowns were found to fail more frequently than multiunit FDP restorations, and failures were often due to post debonding. The masticatory forces acting on single crowns result in buccolingual forces,[31] and these may explain their greater post detachment. The lower success rate recorded for PRDPAs agrees with previously published studies,[12,23,31,41,42] and probably reflects the greater stresses acting on the PRDPAs during mastication or the insertion/removal of the prosthesis.

In agreement with previous studies,[10,12,13,19-23] debonding of the post and secondary caries was the most common failure mode recorded in this study (Fig. 2). The absence of an adequate ferrule effect promotes debonding.[21] The amount of coronal tissue loss has been shown to be a relevant factor in predicting tooth failure.[32,33]

The literature lacks studies that can establish with certainty the specific factors that contribute to failure of a fiber post restoration.[44] However, maximizing dental tissue preservation and interface adhesion and providing a ferrule represent the best clinical options when restoring endodontically treated teeth with fiber posts.

CONCLUSIONS

On the basis of the clinical data obtained, this study suggests that the rehabilitation of endodontically treated teeth with light-transmitting quartz fiber posts and FDPs could be performed with a high success rate of 85% within a period of 5.88 ±1.37 years.

Favorable failure patterns, such as restoration detachments with no root fracture, allowed the recovery of 12 of 14 teeth with failed restorations, bringing the final survival rate of the teeth to more than 98%.

The high prevalence of debonding failures observed suggests that dentin adhesives and cementation techniques need to be improved. The significant association found between failures and posterior teeth of the maxillary arch (*P*=.018) also suggests the use of simplified and less technique-sensitive cementation procedures.

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Corresponding author:
Dr Candida Parisi
University of Bologna
Via S. Vitale 59 - 40125 Bologna
ITALY
Email: candida.parisi@unibo.it

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Book Review

Soft Tissue Management: The Restorative Perspective – Putting Concepts into Practice by Ariel J. Raigrodski, DMD, MS

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The book focuses on utilizing traditional and modified clinical procedures to manipulate the soft tissues in order to ensure successful esthetic outcome in fixed prosthodontics. The book begins with descriptive anatomy of soft and hard tissues and their intimate relationship as well as reaction to pontics and implant abutments following replacement of extracted teeth. Beautiful illustrations are used to describe tooth preparation and finish line location in respect to the gingival margins while minimizing soft tissue trauma. A chapter is devoted to fabrication of interim restorations using direct and indirect techniques as well as CAD/CAM technology with special emphasis on maintaining gingival health. The author then goes to describe the art of impression making and soft tissue management techniques, and how this information is relayed to the dental laboratory for processing. The book ends with prosthetic delivery techniques, while describing and comparing cement-retained vs. screw-retained implant-supported restorations. The book will make an excellent addition to the library of general dentists and prosthodontists.

Shereen Azer, BDS, MSc, MS

The Ohio State University