Randomized Controlled Clinical Pilot Trial of Titanium vs Glass Fiber Prefabricated Posts: Preliminary Results After Up to 3 Years

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Purpose: This randomized parallel-group clinical pilot study aimed to compare the clinical outcome of prefabricated rigid titanium to glass fiber endodontic posts when luted with self-adhesive universal resin cement. ***Materials and Methods****:* Ninety-eight patients in need of postendodontic restoration were assessed for eligibility. Ninety-one patients met the selection criteria and were randomized and allocated to 2 intervention groups. Forty-five participants were treated using a titanium post and 46 participants received a glass fiber post, each in combination with composite core buildups for postendodontic restoration. All posts had a diameter of 1.4 mm and a length of 13 mm and were cemented 8 mm within the root canal with self-adhesive universal resin cement. A circumferential ferrule of 2 mm was always provided. Surgical crown lengthening was necessary in 13 cases. Patients were observed in intervals of 3, 6, 12, 24, and 36 months after post placement. ***Results:*** After 24 to 36 months (mean ± SD: 27.9 ± 5.6) of observation following post placement, 1 tooth was extracted because of changes of the prosthetic treatment plan. No failures were observed among the 88 patients with follow-up data. ***Conclusions:*** Both titanium and glass fiber reinforced composite posts result in successful treatment outcomes after 2 years. The material combination used seems to be appropriate in the short term for cementing endodontic posts, irrespective of the post material. *Int J Prosthodont 2007;20: 499–503.*

The choice of an appropriate post material for the restoration of endodontically treated teeth remains controversial.[1–3] Fiber-reinforced composite (FRC) posts have been recommended because of their dentin-like Young's Modulus.[2,4] They are assumed to allow teeth to flex under applied loads, leading to improved stress distribution between post and dentin.[5] It is also suggested that the risk of root fracture is reduced.[6] However, stress may concentrate between cement and the endodontic post, which may increase the risk of loss of adhesion.[7] Further, it has been argued that the use of flexible materials may introduce secondary caries along the crown margins of the final restorations, especially on the palatal aspect of anterior teeth.[8]

In contrast, a more rigid post is thought to allow less invasive preparations with smaller post diameters[9,10] and avoid deformation of the entire post-core assembly,[8] thus preventing the risk of secondary caries. Root fractures have been attributed to extreme differences in rigidity of post and root dentin with stress concentrations inside the root.[7] As Torbjörner et al[1] hypothesized, there may be a choice between a low modulus post possibly leading to nonfatal failures or a high modulus post with nonrestorable failures that may occur later or less frequently. However, clinical studies on the longevity of FRC post restorations are scarce, and whether FRC posts offer benefits over metal posts in terms of restoration and tooth survival is unclear.[10,11]

Thus, a randomized parallel-group clinical pilot study was conducted to evaluate the effect of prefabricated titanium versus prefabricated glass fiber–reinforced composite posts on the clinical outcome of postendodontic restorations. The authors hypothesized that glass fiber post restorations would result in superior restoration and tooth survival compared to restorations with prefabricated titanium posts.

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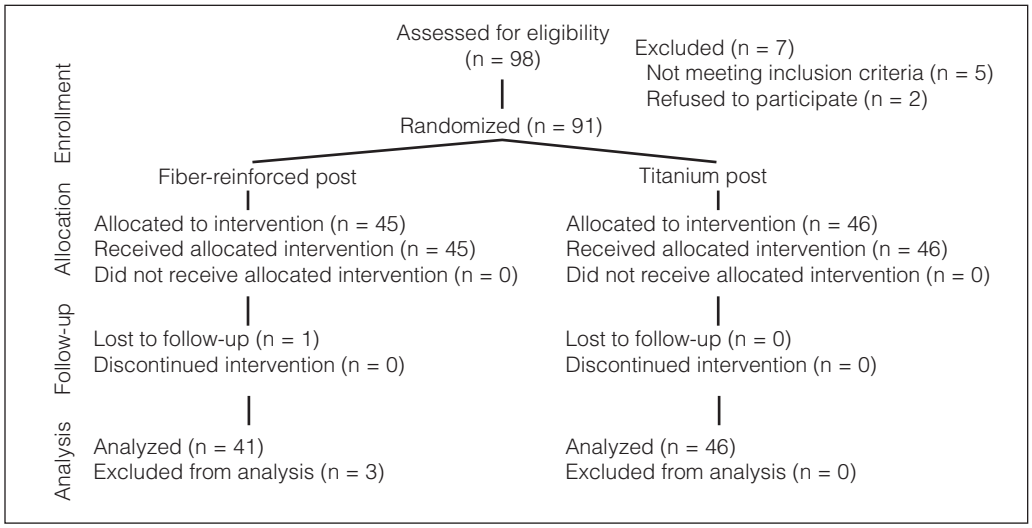

Fig 1 Flow diagram of the study design according to CONSORT statement by Moher et al.

Materials and Methods

Patient Selection, Tooth Selection, Study Design

This study was a randomized parallel-group clinical pilot study. Between January 2003 and April 2004, 98 patients in need of postendodontic restoration were screened and assessed for eligibility. The following inclusion criteria had to be met by the patient or the tooth to be eligible: *(1)* 2 or fewer cavity walls remaining,[12] *(2)* symptom-free root canal filling with a minimum apical seal of 4 mm, *(3)* no or no untreated advanced periodontitis, (4) more than type II tooth mobility,[13] and *(5)* willingness to return at regular intervals for at least 5 years for evaluation. Participants had to be willing to undergo surgical crown lengthening to provide a proper ferrule, if necessary. Furthermore, teeth were excluded if the residual root canal thickness was less than 1 mm,[14] if patients showed clinical symptoms of bruxism, and if the post placement was planned under an existing crown. The final restoration had to be cemented within 3 month after post placement. Each subject gave written informed consent before entering the study, which was approved by the institutional review board of Charité Universitätsmedizin Berlin.

Ninety-eight patients were screened for eligibility. Seven patients were excluded: 5 did not meet the inclusion criteria and 2 refused to participate (Fig 1). Ninety-one patients met the inclusion criteria. Each patient received an identification number and was randomly allocated to 1 of 2 intervention groups. Block randomization with a block length of 4 was performed based on a random number list. Group assignments were placed in consecutively numbered sealed envelopes, which were opened by the treating clinician immediately prior to post placement. All patients received the allocated intervention. Forty-six participants were treated using a titanium post (Fiberpoints Root Pins Titanium, Schuetz Dental Group) and 45 participants received a glass fiber post (Fiberpoints Root Pins Glass, Schuetz Dental Group), each in combination with composite core buildups (Cavex Clearfil, Kuraray). Each patient received only one post restoration as part of this study. All posts were placed by a single experienced operator with expertise in the field of postendodontic treatment.

Variables and Review Procedure

At the baseline examination, the patient's age and gender were recorded. The functional status was determined by the degree of attrition (no attrition, degree I or more)[15] and the type of tooth guidance was determined (combined anterior/canine guidance; canine guidance; group function). To describe the teeth to be restored, the tooth type, number of proximal contacts (0, 1, or 2), type of antagonistic contact (periodontal support, no periodontal support, no antagonist), tooth mobility (yes/no), number of surfaces providing adhesion for core buildup (1 to 3), post length within the root canal (mm), need for post shortening (yes/no), distance of the post tip to the crestal bone level (mm), bone loss (% of root length), type of final restoration (single crown, fixed partial prosthesis, combined fixed-removable partial denture), and the date of post placement were recorded. Prior to the post placement, silicon impressions were taken of each tooth to document the amount of hard tissue loss prior to tooth restoration.

Treatment

The endodontic treatments were performed by dental students of the dental clinic of Charité Universitäts-

medizin Berlin. After a minimum of 24 hours following endodontic therapy, the gutta-percha was removed (Gates-Glidden-burs) leaving 4 mm or more of root filling in the apical portion. The root canal was controlled for gutta-percha remnants with a surgical loupe at a 2.5-fold magnification. The root canal was prepared with a tapered drill of 1.4 mm diameter (Fiberpoints Root Pins post kit, Schuetz-Dental) to achieve an intraradicular post length of 8 mm. Root canals and tooth surfaces were cleaned with an air abrasion system (DentoPrep, Aluminium Oxide Microblaster, Rønvig and Cojet, 3M ESPE). The post space was rinsed with a 2% chlorhexidine solution and dried with paper points. The posts were cleaned with acetone. After air-drying, silane (ESPE-SIL, 3M ESPE) was applied and air dried again. Titanium posts (Fiberpoints Root Pins Titan, Schuetz Dental) or glass fiber–reinforced composite posts (Fiberpoints Root Pins Glass, Schuetz Dental) with a diameter of 1.4 mm and a length of 13 mm were luted with self-adhesive resin cement (RelyX Unicem, 3M ESPE), according to the treatment group. The self-adhesive resin cement was applied on the post and inserted into the root canal. The cement was light cured for 2 seconds (Optilux light-curing unit, Demetron Research Corp) and excess material was removed. Final light curing was performed for 1 minute. Composite cores (NewBond, Kuraray) were built up according to the manufacturer's instructions. When the post diameter was exposed due to the crown preparation, bonding material (NewBond, Kuraray) was applied to avoid disintegration of the fiber-matrix bond.[16] The level of the finishing line for the final restoration ended at least 2 mm below the composite buildup in dentin to ensure a proper dentin ferrule design. Surgical crown lengthening had to be performed before post placement in 13 cases (2 in the glass fiber group and 11 in the titanium group). The final restorations were made by dental students of the dental clinic of Charité Universitätsmedizin Berlin.

Follow-up Procedures

Post placement was considered as the baseline for the analysis. Time until failure or censoring (ie, last follow-up examination) was recorded. Patients were recalled in intervals of 3, 6, 12, 24, and 36 months for a clinical examination. The clinical examination was performed by one blinded examiner who was not the operator. Follow-up examinations were performed with a dental probe and mirror to detect marginal gap formation of the restorations. One year after restoration placement, a radiograph was taken to exclude the possibility of radiographic symptoms of failure, such as a periodontal lesion as a symptom of root fracture.

The primary endpoint was loss of restoration for any reason. Secondary endpoints were tooth loss, post retention, vertical or horizontal root fracture, post fracture, endodontic failure, secondary caries, and failure of the core buildup.

Table 1 Patient Characteristics in the Study Groups (n)

Characteristic	Titanium (n = 46)	Glass fiber (n = 45)
Male	21 (42%)	25 (50%)
Female	25 (58%)	20 (50%)
Age (y) (mean ± SD)	52.3 (14.2)	49.2 (14.8)
Tooth guidance		
Anterior-canine	15 (33%)	15 (33%)
Canine-canine	14 (30%)	14 (31%)
Group function	17 (37%)	16 (36%)
Attrition		
0–I	36 (78%)	36 (80%)
≥ II	10 (22%)	9 (20%)

Table 2 Tooth Characteristics in the Study Groups

Characteristic	Titanium (n = 46)	Glass fiber (n = 45)
Tooth type		
Incisor	12 (26%)	15 (34%)
Canine	10 (22%)	7 (15%)
Premolar	19 (41%)	18 (39%)
Molar	5 (11%)	5 (12%)
Tooth mobility		
0	44 (96%)	38 (85%)
I	2 (4%)	6 (13%)
II	0 (0%)	1 (2%)
No. of proximal contacts		
0	3 (6%)	4 (9%)
1	15 (33%)	14 (31%)
2	28 (61%)	27 (60%)
Type of antagonist		
Periodontal support	44 (96%)	44 (98%)
Other	2 (4%)	1 (2%)
Post length within root canal (mm) (SD)	9.3 (1.4)	9.4 (1.2)
Distance bone crest to post tip (mm) (SD)	6.4 (1.4)	6.0 (2.1)
No. of adhesive surfaces		
1	33 (72%)	31 (69%)
2	12 (26%)	11 (24%)
3	1 (2%)	3 (7%)
Bone loss (%) (SD)	14.8 (12.6)	18.1 (17.9)
Post shortened		
Yes	20 (44%)	26 (56%)
No	13 (29%)	32 (71%)
Final restoration*		
Single crown	28 (61%)	24 (59%)
FPD	10 (22%)	13 (32%)
CF-RPD	8 (17%)	4 (9%)

*Four final restorations in the glass fiber group are missing due to drop out.
FPD = fixed partial denture; CF-RPD = combined fixed-removable partial denture.

Statistical Analysis

For descriptive purposes, frequencies and percentages of measured baseline characteristics were tabulated (Tables 1 and 2).

Results

A total of 87 patients were followed for 24 to 36 months. One patient was lost to follow-up immediately after restoration placement. After randomization, 3 patients were excluded from the study. One tooth was extracted due to a change of the prosthetic treatment plan. Furthermore, 2 participants were excluded since no definitive restoration had been placed within the pre-specified period of 3 months. One of these teeth developed secondary caries after 10 months, and one tooth fractured after 9 months horizontally at the gingival level. All of these 4 patients had been allocated to the glass fiber group (Fig 1). All patient and tooth characteristics were relatively evenly distributed among the 2 experimental groups as a result of randomization (Tables 1 and 2).

The 87 patients remaining in the study were followed for a mean period of 27.9 (5.6) months (total tooth-time: 1,452 tooth-months). Among these 87 posts, no failures were observed over the 2 to 3 year observation period.

Discussion

The present randomized parallel-group clinical pilot study was set up to investigate the impact of the material of prefabricated endodontic posts on the clinical outcome of restored endodontically treated teeth. Among the teeth that were appropriately restored and remained in the study, no failures were observed over a 2- to 3-year period. In an intention-to-treat analysis, 2 failures (1 secondary caries and 1 crown fracture) were observed in the FRC group. However, these teeth had not received a final restoration within 3 months after post placement, and so may not be related to the post material. Hence, prefabricated titanium posts and FRC posts yield high short-term success-rates when cemented with self-adhesive resin cement.

A surgical loupe at a 2.5-fold magnification was chosen to eliminate gutta-percha remnants from the root canal walls. It has been shown the root canal filling is often not completely removed from the root canal wall after post space preparation. This is of clinical importance, since it would reduce the adhesive surface achievable for post luting.[17] The self-adhesive cement material was used since it is delivered by the manufacture in capsules, which must be activated and machine-mixed. Thus, variations in cement quality could be excluded. The potential of this material to bond effectively to dentin and root dentin was recently demonstrated in vitro.[18,19] Both fiber-reinforced and titanium posts in combination with this self-adhesive resin have been shown to be appropriate in terms of load capability in vitro.[20] Cojet treatment and silane application were used because they are shown to be of advantage in regard to retentive strength between post and luting cement.[21,22] The cleaning of the dentin surface by a Microblaster was chosen to remove remnants of the impression material.

To date, only a few clinical studies have evaluated the survival of fiber-reinforced posts. For carbon fiber posts, failure rates of 2% after 32 months (range: 27 to 41 months)[23] and 5% after 4 years of clinical service[24] have been found in retrospective clinical studies. In a prospective study, the overall failure rate was 7.7%[25] after 28 months (range: 6.7 to 45.4 months) at risk. After a period of clinical service ranging from 1 to 6 years, 3.2% of carbon and glass fiber posts failed in a retrospective clinical study.[26] In a prospective clinical trial comparing a carbon fiber–reinforced endodontic post (n = 16) with a conventional gold alloy cast post and core (n = 11), failure rates of 25% and 9% were found, respectively.[27] Another study observed a 30-months failure risk of 1.7% for quartz fiber posts.[28] In a prospective observational study of 149 glass fiber posts placed in 122 patients, an average annual failure rate of 6.7% was found after an observation time of up to 56 months.[29] The only published randomized controlled trial for postendodontic restorations investigated the survival of endodontically treated premolars with MOD-cavities restored by either full cast coverage or direct composite restoration. The crown buildup was performed using a carbon fiber post and composite core. The overall risk of failure after 3 years was 13%.[30] However, single crown placement for teeth that present with an MOD-cavity remains questionable, and thus the results should be interpreted with some caution. The clinical studies mentioned above show a wide range of survival rates for fiber-reinforced post restorations. This may be due to variables such as tooth type, type of final restoration, and presence of adjacent teeth, which were found to be significant predictors of failure rates in endodontically treated teeth restored with glass fiber posts.[29]

Surprisingly, no clinical data are available for prefabricated titanium posts, even though this is a common treatment option in dental practice. The short-term analysis of the current study suggests that the postulated stress concentration caused by a more rigid material may not be clinically relevant. The effect of the post material as such is potentially overestimated. No impact of the post material on the primary outcome (restoration survival) or secondary outcomes (eg, secondary caries) was found. All teeth received a 2-mm ferrule preparation, which may explain the favorable results observed. The importance of this parameter was recently shown in a laboratory study of maxillary central incisors using the same material combination as in the present study.[20]

It is important to note that the data presented here are preliminary short-term results after at least 2 years of clinical service. Therefore, the results should be interpreted with caution. It is possible that clinically mean-

ingful differences between glass fiber and titanium posts in restoration survival will emerge in the long-term. Furthermore, longer observation periods are required to confirm the long-term sustainability of the post bonding achieved with the resin cement used in this study.

Conclusion

After 2 years of clinical service, both glass fiber posts and titanium posts can be highly successful in post-endodontic restorations when used with a self-adhesive universal resin cement and a composite core. Longer observation periods are necessary to reveal or exclude clinically meaningful differences in success rates between the 2 post systems.

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