Evaluation of fiber posts vs metal posts for restoring severely damaged endodontically treated teeth: a systematic review and meta-analysis

Xiaodong Wang, MDS*/Xin Shu, MDS*/Yingbin Zhang, MDS/Bin Yang, PhD/Yutao Jian, PhD/Ke Zhao, PhD

Objectives: This review was undertaken to answer a controversial clinical question with high-quality evidence: When severely damaged teeth are restored, which type of post (metal or fiber) demonstrates superior clinical performance? Data sources: The meta-analysis was conducted according to the guidelines in the Cochrane handbook. Electronic databases (MEDLINE, EMBASE, CENTRAL) and gray literatures were screened up to January 2018. Only randomized controlled trials (RCTs) with follow-up of at least 3 years were included. The quality of included studies was assessed by the Cochrane Collaboration’s tool. Meta-analysis compared survival, success, post debonding, and root fracture incidence of teeth restored with fiber and metal posts. The GRADE system (Grading of Recommendations, Assessment, Development and Evaluations) was used to assess the strength of the evidence. Of 1,511 records, 14 full texts were obtained. Only four RCTs with follow-up times of 3 to 7 years met the selection criteria. The methodologic quality of included RCTs was low risk of bias. Fiber posts presented significantly higher survival rates than did metal posts (RR 0.57, 95% CI: 0.33 to 0.97, \( P = .04 \)), while no difference was observed in success rates, post debonding rates, or root fracture rates. The GRADE assessment indicated a high quality of evidence for survival rates and a moderate quality for success rates. Conclusion: It was concluded that fiber posts displayed higher medium-term (3 to 7 years) overall survival rates than did metal posts when used in the restoration of endodontically treated teeth with no more than two coronal walls remaining. (Quintessence Int 2019;50:8–20; doi: 10.3290/j.qi.a41499)

Key words: meta-analysis, post, success rate, survival rate, tooth defect

The retention of severely damaged teeth is sometimes controversial, especially when the value of endodontic treatment is limited due to a questionable prognosis. Dental implants have been promoted as an acceptable but more non-conservative alternative for clinicians. However, according to a published systematic review, compromised but adequately treated and maintained teeth showed long-term (over 15 years) survival rates comparable with those of implant-supported single crowns. Additional advantages of endodontic treatment and subsequent restorations are that they are less invasive, more psychologically acceptable, and of relatively low cost. These may provide an opportunity for the retention of natural teeth, even with severe hard-tissue loss, and represent a cost-effective alternative to tooth extraction and implant placement.

Endodontically treated teeth (ETT) are brittle and prone to fracture. Therefore, post application is essential in the restoration of ETT with substantial tissue loss, increasing the fracture resistance of restored teeth, and providing retention for the core material and coronal restoration. With proper design, noble alloy cast posts and cores are considered the “gold standard,” due to high clinical success rates, and demonstrate a higher fracture resistance for restored teeth compared with fiber posts. Conversely, the incidence of root fracture is relatively lower for fiber posts, since their elastic moduli are comparable with that of natural dentin. Compared with catastrophic vertical root fractures related to the use of cast metal posts for restoring teeth, bevel and horizontal fractures in the coronal aspects of the roots are reportedly the most common...
failure mode related to the use of fiber posts for restoring teeth.11,12

A recent systematic review of randomized controlled trials (RCTs) compared survival rates between fiber and metal posts, but only descriptive results were reported due to the high heterogeneity.13 Other relevant systematic reviews were based on observational studies, presenting a high risk of bias and a relatively lower power of evidence.14,15 To the present authors’ knowledge, without a definite conclusion, selection of the most adequate type of post for the restoration of ETT remains controversial and a major concern in dentistry.

The amounts of residual cavity walls should be considered as the predominant factor affecting the survival of both ETT and the restorations.16 The survival rates increased when more residual tooth tissue remained, for both metal- and fiber-post-supported restorations.13 A prospective clinical study with 5-year follow-up showed that, despite the types of posts and cores used, coronal restorations with “substantial dentin height” appeared to have significantly higher survival rates than those with “minimal dentin height” (98% vs 93%).17 However, post placement did not seem to affect the survival of ETT in cases of sufficient coronal tissue remaining.18 Results of a systematic review showed that although post placement appeared to have a significant influence on reducing the catastrophic failure of ETT with severe defects, when three or four coronal walls remained, post placement seemed to have no influence.19 Therefore, in light of the positive effects, deleterious side-effects, and extra costs of posts, only in cases of severe coronal tissue loss should posts be used. Comparing the clinical performance of post systems without identifying the remaining coronal walls could result in substantial heterogeneity.

The aim of this systematic review was to answer the following question: When severely damaged ETT are restored, which type of intraradicular post (metal or fiber) demonstrates superior clinical outcomes in terms of survival and success rates?

Data sources

The meta-analysis was conducted according to the guidelines of the Cochrane Handbook (http://handbook-5-1.cochrane.org/). The study protocol was registered after the initial screening stage (Prospero CRD42015017644). Slight modification was made to the initially registered protocol. For the reasons described previously, only the clinical performance of ETT with no more than two coronal walls was included in this systematic review.

Literature published in English and Chinese was obtained through an electronic search of the following databases (up to January 2018): MEDLINE via PubMed, EMBASE via embase.com, and CENTRAL via the Cochrane Library. The search strategy included the following key word combinations (MeSH and free-text terms in Title/Abstract): “Post and Core Technique [MeSH Terms]”, “fiber*”, “fibre*”, “glass-fib*”, “quartz-fib*”, “carbon-fib*”, “non-metal*”, “metal*”, “cast*”, “wrought”, “screw”, “titanium”, “Ti”, “cobalt-chromium”, “Co?Cr”, “stainless”, “gold”, “alloy”, “prefabricate*”, “custom”, “endodontic*”, “root canal”, “post*”, “dowel*”, and “pin*”. Gray literature was searched for potentially suitable unpublished clinical trials in ClinicalTrials.gov, Open Grey, and Google Scholar. Additional relevant studies were identified by hand-searches of the references in the retrieved articles.

Resource selection

Initially, two reviewers independently examined the titles and abstracts according to the following inclusion criteria:

- Patients (P): patients with endodontically treated permanent teeth restored with posts and cores. For restored teeth, residual coronal walls should ≤ 2. There was no restriction by gender or tooth position.
- Intervention (I): endodontically treated teeth restored with prefabricated or custom fiber posts, followed by coverage with indirect fixed permanent restorations (crowns or fixed partial dentures [FPDs]).
- Control (C): endodontically treated teeth restored with prefabricated or custom metal posts, followed by coverage with indirect fixed permanent restorations (crowns or FPDs).
- Outcomes (O): survival and success rates of restored teeth (primary outcomes). The survival criterion was defined as an in situ tooth–post complex without extraction. The success criterion was defined as both the restored tooth and restoration being present and clinically acceptable, without intervention or repair needed. Secondary outcomes included incidence of complications including root fracture and debonding of posts.
- Study design (S): RCTs with follow-up time of at least 3 years.

The full texts were analyzed when the titles or abstracts indicated that the inclusion criteria were fulfilled. When necessary, the original author was contacted for further clarification of missing information. Any disagreement between the two reviewers was resolved by consensus. If the disagreement could not be resolved, a third reviewer was involved. Two reviewers independently extracted the data using a data collection form.
Table 1  Characteristics of included studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Study design</th>
<th>Follow-up</th>
<th>Region</th>
<th>Coronal wall</th>
<th>Restorations</th>
<th>Post cement</th>
<th>Post No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloet et al*</td>
<td>RCT</td>
<td>5 y</td>
<td>68 anterior (28 fiber, 40 metal); 123 posterior (63 fiber, 60 metal*)</td>
<td>Fewer than 2 dentin walls (≥ 2 mm) with wide pulp chambers</td>
<td>Single crowns</td>
<td>Dual-curing adhesive cement (Panavia F 2.0)</td>
<td>91</td>
</tr>
<tr>
<td>Sarkis-Onofre et al†</td>
<td>RCT</td>
<td>3 y</td>
<td>40 anterior (21 fiber, 19 metal); 32 posterior (16 fiber, 16 metal)</td>
<td>No remaining coronal wall, or the enamel portion of one wall with no dentinal support (ferrule height, 0–0.5 mm)</td>
<td>Metal-ceramic single crowns</td>
<td>Regular resin cement (RelyX ARC) or self-adhesive resin cement (RelyX U100)</td>
<td>37</td>
</tr>
<tr>
<td>Sterzenbach et al‡</td>
<td>RCT</td>
<td>7 y</td>
<td>27 incisors (15 fiber, 12 metal); 17 canines (7 fiber, 10 metal); 37 premolars (18 fiber, 19 metal); 10 molars (5 fiber, 5 metal)</td>
<td>Two or fewer cavity walls remaining</td>
<td>52 single crowns (24 fiber, 28 metal); 23 FPDs (13 fiber, 10 metal); 4 single crown-RPDs (1 fiber, 3 metal); 8 FPD-RPDs (3 fiber, 5 metal)</td>
<td>Self-adhesive resin cement (RelyX Unicem)</td>
<td>45</td>
</tr>
<tr>
<td>Schmitter et al‡</td>
<td>RCT</td>
<td>5 y</td>
<td>Anterior and posterior (sample size unclear)</td>
<td>Coronal tooth destruction ≥ 40%</td>
<td>Crowns, FPDs, crowns integrated into RDPs</td>
<td>Metal post: zinc phosphate cement (Harvard Dental). Fiber post: composite cement (Variolink II)</td>
<td>50</td>
</tr>
</tbody>
</table>

*About 90% (90/101) of the samples in the metal post group had insufficient (≤ 2 coronal walls) tooth tissue remaining, and therefore, the study was included in the analysis.
†“Absolute failure” refers to catastrophic complications (root fracture, post fracture in root canal, caries, endodontic failure, and periodontal failure) that resulted in tooth extraction.
‡“Relative failure” refers to repairable complications (loss of retention of the post, endodontic failure, and post fracture requiring post replacement).
**Review**

**Assessment of risk of bias and evidence quality**

Methodologic qualities of retrieved studies were evaluated independently by two reviewers according to the guidance provided by the Cochrane Collaboration. The following domains were assessed: sequence generation, allocation concealment, blinding, incomplete outcome data, selective outcome reporting, and other sources of bias. Additionally, quality of the body of evidence and strength of recommendation were assessed according to the GRADE approach by GRADEprofiler 3.6.1 (McMaster University and Evidence Prime).

**Statistical analysis**

Pooled data from all outcomes were subjected to meta-analysis to estimate the risk ratio (RR) and 95% confidence intervals (CI) using the Review Manager (Ver. 5.3). For each outcome, Cochrane’s Q test was applied for analysis of the heterogeneity among included studies. To test the reliability of evidence, outcomes of fixed-effects and random-effects models were compared, but only random-effects estimates were reported to be more conservative. If the heterogeneity of outcomes was higher than 40%, sensitivity analysis was carried out by subgroup analysis, testing for excess studies with significant results. If heterogeneity could not be eliminated, meta-analysis was abandoned and narrative analysis was applied instead. Additionally, publication bias could not be assessed due to the limited number of studies.

**Search results**

An electronic search identified 1,511 potentially relevant articles. The evaluation of titles and abstracts led to the selection of 14 articles, and finally, only four articles met the inclusion criteria. The search strategy is described in Fig 1.

**Characteristics of included studies**

The characteristics of included studies are detailed in Table 1.

<table>
<thead>
<tr>
<th>Fiber post</th>
<th>Metal post</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Drop-out</strong></td>
<td><strong>Failure</strong></td>
</tr>
<tr>
<td>Unclear</td>
<td>Absolute failure(^1): 6 prefabricated fiber posts (1 anterior, 5 posterior); 2 custom fiber posts (2 anterior). Relative failure(^2): 7 prefabricated fiber posts (3 anterior, 4 posterior); 3 custom fiber posts (3 anterior)</td>
</tr>
<tr>
<td>2</td>
<td>2 debonded (1 premolar, 1 anterior); 1 debonded with root fracture (premolar)</td>
</tr>
<tr>
<td>11</td>
<td>1 cervical root fracture (premolar); 1 middle root fracture (incisor); 1 enhanced tooth mobility (canine); 1 core fracture (premolar)</td>
</tr>
<tr>
<td>11</td>
<td>6 extracted (post core-crown loosened and severe decay); 2 post core-crown dislodgement and recemented; 2 crowns cracked or severely chipped; 1 apical alteration</td>
</tr>
</tbody>
</table>
All four included studies were RCTs (parallel design) with follow-up of 3 to 7 years.20-23 Characteristics and reasons for exclusion of 10 studies are listed in Table 2.24-33

For the same clinical trial with multiple publications, only the most recent was included in the analysis. Initially, a study by Naumann et al24 was included in the survival rate calculation, and resulted in marked heterogeneity of meta-analysis ($P = .06$, $I^2 = 59\%$). Sensitivity analysis indicated the following possible reasons: first, the dropout rate of this RCT was as high as 49.4%, which is not acceptable in analysis. In addition, it was the only long-term (11-year) RCT, and the author reported that the survival rates for severely damaged ETT decreased significantly after 8 years, leading to a significantly higher failure rate and heterogeneity compared with results of other included studies. Therefore, the 11-year long-term results were excluded, and data from the 7-year report for the same study were included instead.22

### Risk of bias

The quality assessments are presented in Fig 2. Generally, most studies showed relatively low risk of bias, except for selection bias, since half of the included studies did not conceal allocation. Sarkis-Onofre et al21 and Sterzenbach et al22 mentioned the blinding of participants and personnel or outcome assessment. However, the objective outcome was not likely to be influenced by lack of blinding; therefore, low risk of both performance bias and detection bias was determined.

---

### Table 2 Characteristics of excluded studies and reasons for exclusion

<table>
<thead>
<tr>
<th>Study (year)</th>
<th>Study design</th>
<th>Remaining coronal wall</th>
<th>Fiber post</th>
<th>Metal post</th>
<th>Reasons for exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naumann et al24 (2017)</td>
<td>RCT (11 y) ≤ 2 cavity walls</td>
<td>Glass fiber posts</td>
<td>45 16 12</td>
<td>Titanium posts</td>
<td>Multiple reports</td>
</tr>
<tr>
<td>Naumann et al25 (2007)</td>
<td>RCT (3 y) ≤ 2 cavity walls</td>
<td>Glass fiber posts</td>
<td>45 4 0</td>
<td>Titanium posts</td>
<td>Multiple reports</td>
</tr>
<tr>
<td>Zicari et al26 (2011)</td>
<td>RCT (3 y) &lt; 2 cavity walls (height ≥ 2 mm)</td>
<td>65 prefabricated fiber posts; 26 custom-made glass fiber posts</td>
<td>91 Unclear 2</td>
<td>Gold alloy-based wrought posts and cast cores</td>
<td>Multiple reports</td>
</tr>
<tr>
<td>Qian et al27 (2017)</td>
<td>RCT (2 y)</td>
<td>Custom-made glass fiber posts</td>
<td>48 Unclear 0</td>
<td>Co-Cr alloy cast posts-cores</td>
<td>No description of coronal destruction</td>
</tr>
<tr>
<td>Gbadebo et al28 (2014)</td>
<td>RCT (0.5 y) ≥ 2 mm ferrule</td>
<td>Glass fiber posts</td>
<td>20 2 0</td>
<td>Stainless steel posts</td>
<td>Coronal destruction is inconsistent with our PICO</td>
</tr>
<tr>
<td>King et al29 (2003)</td>
<td>Prospective (80 to 100 mo)</td>
<td>Carbon fiber posts</td>
<td>16 2 0</td>
<td>Wrought precious alloy</td>
<td>Non-RCT</td>
</tr>
<tr>
<td>Ma et al30 (2013)</td>
<td>Retrospective (&gt; 5 y)</td>
<td>Glass fiber posts</td>
<td>73 Unclear 2</td>
<td>Cast titanium posts-cores</td>
<td>Non-RCT</td>
</tr>
<tr>
<td>Turker et al32 (2007)</td>
<td>Prospective (10 to 73 mo)</td>
<td>Polyethylene fiber ribbon-reinforced posts</td>
<td>42 Unclear 0</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Ellner et al33 (2003)</td>
<td>RCT (10 years)</td>
<td>Unclear</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

NA, not applicable.
Data synthesis

Comparison of survival rates  All four studies were included in the analysis of survival rates with follow-up times from 3 to 7 years.20-23 As meta-analysis showed (Fig 3a), fiber posts presented significantly higher overall survival rates than did metal posts (RR 0.57, 95% CI: 0.33 to 0.97, \( P = .04 \)). No heterogeneity was detected among the studies (\( P = .40, I^2 = 0\% \)).

Two studies (Fig 3b) were included for the analysis of survival rates of anterior teeth (5 to 8 years), 20,22 and three studies (Fig 3c) were included in posterior tooth survival rate analysis (3 to 7 years).20-22 The results of meta-analysis indicated that no statistical significance was detected in the anterior zone (RR 0.80, 95% CI: 0.27 to 2.32, \( P = .68 \)) or the posterior zone (RR 0.76, 95% CI: 0.31 to 1.89, \( P = .56 \)), with no heterogeneity in both groups (anterior, \( P = .77, I^2 = 0\% \); posterior, \( P = .62, I^2 = 0\% \)).

Comparison of success, post debonding, and root fracture rates  The same four studies were also included in the analysis of 3- to 7-year success rates.20-23 No statistically significant difference was observed between fiber posts and metal posts (RR 0.78, 95% CI: 0.48 to 1.27, \( P = .31 \)) with low heterogeneity (\( P = .27, I^2 = 23\% \)) (Fig 4).

Studies from Sarkis-Onofre et al21 (3 years) and Schmitter et al23 (5 years) were included in comparisons of post debonding rates. The results indicated that fiber posts and metal posts showed no differences in rates of post dislodgement (RR 1.64, 95% CI: 0.33 to 8.28, \( P = .55 \)) (Fig 5). No heterogeneity was detected between the two studies (\( P = .34, I^2 = 0\% \)).

Sarkis-Onofre et al21 (3 years) and Sterzenbach et al22 (7 years) reported the incidence of root fracture. Meta-analysis presented no statistical significance between fiber and metal posts (RR 2.21, 95% CI: 0.29 to 16.75, \( P = .44 \)) (Fig 6). No heterogeneity was detected (\( P = .46, I^2 = 0\% \)).

GRADE assessment

SoF (summary of findings) tables were generated with GRADEprofiler. Among the six outcomes analyzed in this review, overall survival rates showed high quality of evidence (Fig 7); anterior and posterior tooth survival rates and success rates (Fig 8) showed moderate quality of evidence (all downgraded one level for imprecision), but incidences of post debonding and root fracture showed low quality of evidence (downgraded two levels for imprecision).

Discussion

In the present meta-analysis, all the included studies were well-designed RCTs with low risk of bias, resulting in satisfactory quality of evidence for the primary outcomes.

A published descriptive systematic review comparing fiber and metal posts did not conduct a meta-analysis of RCTs because of high heterogeneity.13 In any exploration of the origin of heterogeneity, residual coronal walls are expected to be one of the determinants. A previous systematic review showed that the high variation in success/survival rates of ETT crowns with the absence of a ferrule or only one coronal wall ranged between 0% and 97%, while higher success/survival rates with lower variation between 66.7% and 100% were present for the three- and four-wall groups.34 Based on the guideline for the type of reconstruction for ETT according to the residual coronal wall, it is recommended that with two to four remaining coronal walls, a post would not be necessary. But with no or one remaining wall, the core material could provide limited retention as well as fracture resistance, and a post is required.35 Consequently, studies on ETT with fewer than two walls were included in the current meta-analysis, and very low
heterogeneity was detected. Therefore, it is suggested that in comparisons of the application and performance of different post and core systems, consideration of remaining coronal walls should be regarded as a prerequisite.

Besides remaining coronal walls, a ferrule is another important factor, since ETT restored with ferrules showed survival rates superior to those of ETT restored without ferrules during 5-year observation. Unfortunately, most included studies did not report detailed information on ferrules and the height of remaining coronal walls. Therefore, the relationship between ferrules and survival/success rates could not be clarified by subgroup analysis. It is suggested that the influence of the ferrule
effect should be based on relatively sufficient support from coronal walls. The results of a 6-year RCT demonstrated that, for restored teeth without coronal walls, failure risks were similar, regardless of the presence or absence of ferrules.

Differences in remaining dental tissue, post depth and preparation, materials, and processing techniques for posts/cores, as well as cement selection, etc, resulted in survival rates with a large variation among included studies (88% to 97.6% for fiber posts, 66% to 97.6% for metal posts). Therefore, for comparisons of clinical performance of different post systems, meta-analysis with only RCTs is the best choice to minimize possible influencing factors. The results showed that fiber posts pres-
Fiber posts compared to metal posts for severely damaged ETT

**Patient or population:** patients with severely damaged ETT  
**Settings:** University  
**Intervention:** Fiber posts  
**Comparison:** Metal posts

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Illustrative comparative risks* (95% CI)</th>
<th>Relative effect</th>
<th>No. of participants (studies)</th>
<th>Quality of the evidence (GRADE)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assumed risk</td>
<td>Corresponding risk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal posts</td>
<td>147 per 1,000</td>
<td>84 per 1,000 (49 to 143)</td>
<td>RR 0.57 (0.33 to 0.97)</td>
<td>461 (4 studies)</td>
<td>++++ high</td>
</tr>
<tr>
<td>Fiber posts</td>
<td>103 per 1,000</td>
<td>59 per 1,000 (34 to 100)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The basis for the assumed risk (eg, the median control group risk across studies) is provided in footnotes. The corresponding risk (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI). (CI, confidence interval; RR, relative risk). GRADE Working Group grades of evidence

**High quality:** Further research is very unlikely to change our confidence in the estimate of effect.  
**Moderate quality:** Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.  
**Low quality:** Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.  
**Very low quality:** We are very uncertain about the estimate.

*Fig 7* Summary of findings for survival rates.

---

Fiber posts compared to metal posts for severely damaged ETT

**Patient or population:** patients with severely damaged ETT  
**Settings:** University  
**Intervention:** Fiber posts  
**Comparison:** Metal posts

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Illustrative comparative risks* (95% CI)</th>
<th>Relative effect</th>
<th>No. of participants (studies)</th>
<th>Quality of the evidence (GRADE)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assumed risk</td>
<td>Corresponding risk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal posts</td>
<td>206 per 1,000</td>
<td>161 per 1,000 (99 to 261)</td>
<td>RR 0.78 (0.48 to 1.27)</td>
<td>461 (4 studies)</td>
<td>+++− moderate†</td>
</tr>
<tr>
<td>Fiber posts</td>
<td>153 per 1,000</td>
<td>119 per 1,000 (73 to 194)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The basis for the assumed risk (eg, the median control group risk across studies) is provided in footnotes. The corresponding risk (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI). (CI, confidence interval; RR, relative risk). GRADE Working Group grades of evidence

**High quality:** Further research is very unlikely to change our confidence in the estimate of effect.  
**Moderate quality:** Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.  
**Low quality:** Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.  
**Very low quality:** We are very uncertain about the estimate.

†Downgraded one level for imprecision (total sample size [461] is relatively small).

*Fig 8* Summary of findings for success rates.
ent higher 3- to 7-year overall survival rates compared with metal posts for ETT with severe coronal damage. Among the included studies, four different metal post systems were involved (gold-alloy-based wrought posts,20 Co-Cr casting posts,21 titanium prefabricated pin posts,21 and titanium screw posts21), three of which demonstrated comparable survival rates without statistically significant differences compared with fiber post groups (86.14% [metal] vs 91.21% [fiber] for 5 years;20 97.56% [metal] vs 97.30% [fiber] for 3 years;21 93.48% [metal] vs 91.11% [fiber] for 7 years22). In contrast, in the study by Schmitter et al,23 it was found that the failure rate of prefabricated screw titanium posts was significantly higher than that of fiber posts (88.00% vs 66.00% for 5 years). Interestingly, all six failures in the fiber post group were due to post core-crown loosening and severe decay, while the 14 teeth in the metal post group were extracted because of root fracture or perforations. Root canals were enlarged and tapped by means of a tapper (Brasseler), followed by insertion of parallel-sided screw posts, and root fractures or perforation were observed subsequently.21 It has been proved that threaded metal posts represent a high risk of root fracture,38 since tapping inside the root exerts more stress on the tooth.39 Moreover, clinicians should pay more attention to parallel threaded posts, which displayed two times greater root strain and stress concentration compared with tapered threaded posts.40 In summary, the use of parallel-sided screw metal posts should be avoided if possible. According to methodology, although titanium parallel-sided screw posts demonstrated much lower survival rates, there is insufficient evidence to exclude them from the meta-analysis, especially when heterogeneity is negligible. Additionally, according to a published systematic review, no statistically significant difference was detected between the 5-year success rates of prefabricated titanium and those of cast posts.13

Further, it was found that ETT restored with metal posts were extracted more often due to endodontic failure. The elastic modulus mismatch between roots and metal posts led to a stress concentration at the bonding interface between the post and the luting material,41 which therefore resulted in microgaps and could increase bacterial colonization as well as risk for apical periodontitis.22 An in-vitro study reported that glass fiber posts and resin-supported polyethylene fiber posts exhibited less microleakage compared with stainless steel posts and zirconia posts.42 With no access to root canal retreatment, teeth restored with a cast post-and-core restoration but with a peri-apical lesion present are very likely to be extracted.43 Three studies reported survival rates of anterior and posterior teeth, but only two studies were included in anterior tooth analysis, because, in the study by Sarkis-Onofre et al,21 no failure was found in the anterior zone for both groups (both-arm-0-event, BA0E). Also, the study by Schmitter et al23 was excluded since detailed information for anterior and posterior teeth was unclear. With the limited number of included studies and modest sample size, no statistical significance was detected between fiber and metal posts for both anterior and posterior teeth. Reported reasons for failure were similar for anterior and posterior teeth, including root fracture, core fracture in fiber posts, and endodontic failure, as well as root fracture for metal posts.20-22

Debonding was considered the most common type of failure with post-retained restorations.44-45 Only two studies were included in the meta-analysis,21,22 since the other two studies did not report the incidence of debonding.20,22 No statistically significant difference was found when fiber and metal posts were compared, but in the study by Sarkis-Onofre et al,21 dislodgement was observed in two of a group of 37 prefabricated fiber posts, compared with none in a group of 43 cast Co-Cr posts. Post retention was determined by micromechanical interlocking, chemical bonding, and sliding friction. Therefore, perhaps the types of fabrication rather than the materials should count for the retention of posts. This was supported by an in-vitro study showing that cast metal posts had greater retention than fiber and zirconia posts because of superior fitting.46 Similarly, customized fiber posts also showed superior bond strength compared with prefabricated metal or fiber posts.47,48 The above results could be explained by cement thickness, since thicker cement might lead to increased polymerization stress and decreased bending strength.48 Simultaneously, with a lack of direct visualization and control of adhesive procedures, the predictability of cement could be further jeopardized.48 For some prefabricated posts, since their adaptation to root canal anatomy was not always good (eg, oval canal), lateral compaction of smaller accessory posts was required after placement of a master post. A well-prepared root canal for post space and the selection of post taper/diameter are essential to acquire initial friction retention during a prefabricated post try-in, which will contribute to the prevention of post debonding.

In the studies by Cloet et al20 and Schmitter et al,23 the exact number of root fractures is unclear. No statistically significant differences were found in the incidence of fracture between the two post systems in meta-analysis of the remaining two studies.21,22 In accordance with these results, a previous review indicated that root fracture incidence for metal posts was 5.13% per year, which is comparable with that reported for fiber posts (4.78% per year).14 Actually, root fractures are usually more unfavorable and catastrophic with metal posts,14,23 since potential fracture locations are expected to be apical with
metal posts, but coronal (cervical) with fiber posts. In addition to similar elastic moduli and better stress dissipation in ETT restored with fiber posts, a thick cement layer can also act as stress absorption under functional loading, reducing the possibility of root fracture. Finite Element Analysis indicated that the use of a post-and-core material with a lower elastic modulus and a cement with a higher elastic modulus could result in high stress concentrations in the cement layer, leading to a reduction in stress and deformation in the residual root. However, it must be kept in mind that the placement of a post, regardless of its composition, produces a potential risk to the integrity of the tooth. Filling the root canal space with a material with stiffness that varies from that of pulp will make it impossible to replicate the stress distribution of the original tooth, thus increasing the incidence of root fracture.

In the inclusion criteria, the follow-up time was stipulated to be at least 3 years, since observation of less than 3 years was generally regarded as a short-term investigation. Although the quality of evidence was relatively high and credible, it should be noted that all the results of the present review were based on medium-term studies (3 to 7 years), and the conclusions should not be extrapolated to long-term situations. Long-term prospective controlled clinical trials are very rare because they are difficult to conduct and have high dropout rates. Up to now, only one long-term RCT could be found on this topic, in which cumulative survival probability for glass-fiber posts (58.7%) was significantly lower than that for metal posts (74.2%) after 11 years’ observation. Failure reasons for fiber posts were root fracture (4/29), endodontic failure (2/29), core fracture (1/29), tooth fracture (1/29), secondary caries (1/29), and tooth mobility (1/29) after 11 years’ follow-up, while failures for metal posts were attributed to endodontic failure (5/27) and root fracture (1/27). Apart from the high dropout rate (approximately 50%), an interesting trend found in this study was that, for severely damaged teeth (defects in more than two walls), the Kaplan-Meier curve dropped rapidly after 8 years for both groups. Long-term survival of ETT with extensive coronal tissue loss is highly uncertain and could be quite different from medium-term results.

Conclusions

Based on the high level of evidence from RCTs, fiber posts display higher medium-term (3 to 7 years) survival rates than do metal posts in the restoration of ETT with fewer than two coronal walls remaining. With the limited included studies and sample sizes, no differences are evident between fiber and metal posts in anterior teeth, posterior teeth, post debonding, and root fracture.

Acknowledgment

This work was supported by the National Natural Science Foundation of China under grant No. 81470767 and No. 81600907.

References


27. Qian YM, Zhong Q, Chen S. Comparison of clinical effects of Co-Cr alloy cast post-core and everStick fiber post in restoration of labially or lingually inclined maxillary central incisor. Shanghai Kou Qiang Yi Xue 2017;26:89–93.


33. Wang et al.