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A Systematic Review of Dowel (Post) and Core Materials and Systems

Joanna N. Theodosopoulou, DDS, MSc & Konstantinos M. Chochlidakis, DDS

Private Practice, Athens, Greece

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Systematic review; post and core materials; dowel and core materials; post and core systems; dowel and core systems; endodontically treated teeth; randomized controlled clinical trials; controlled clinical trials; cohort studies.

Correspondence
Joanna N. Theodosopoulou, 35, Alexandras Ave., 1st Floor, Athens 114 73, Greece.
E-mail: joanna_theodosopoulou@yahoo.gr

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Abstract

Purpose: The aim of this systematic review was to determine which dowel (post) and core system is the most successful when used in vivo to restore endodontically treated teeth.

Materials and Methods: A MEDLINE, a Cochrane, and an EMBASE search (three specified searches) were conducted to identify randomized (RCT) and nonrandomized controlled clinical trials (CCT), cohort (CS), and case control studies (CCS) until January 2008, conducted on humans, and published in English, German, and French, relating to dowel and core systems for restoring endodontically treated teeth. Also, a hand search was conducted, along with contact with the authors when needed.

Results: The MEDLINE, Cochrane, and EMBASE searches identified 997, 141, and 25 published articles, respectively. Ten articles from the MEDLINE and seven articles from the Cochrane search (that were also identified in the MEDLINE search) met the inclusion and validity assessment criteria. Six out of the ten studies were RCTs, two were CCTs, and two CSs. The RCT studies suggest that carbon fiber in resin matrix dowels are significantly better than precious alloy cast dowels (number needed to treat, NNT = 8.30). Tapered gold alloy cast dowels are better than ParaPost® gold alloy cast dowels (NNT = 13.15). ParaPost® prefabricated dowels are slightly better than ParaPost® cast dowels (NNT = 175.4). Glass fiber dowels are significantly better than metal screw dowels (NNT = 5.46), but worse than titanium (NNT = −21.73) (moderately). Carbon fiber dowels are worse than gold alloy cast dowels (significantly) (NNT = −5.81) and than amalgam dowels (NNT = −125) (slightly). The CCT studies suggest that metal dowels are better (NNT = 21.73) but also worse than cast dowels (NNT = −33.33) depending on the remaining amount of coronal hard tissue. Quartz fiber dowels show success rates similar to and worse than glass fiber-reinforced dowels (NNT = −37.03). The results from the CS studies suggest that carbon fiber in resin matrix dowels are better (moderately) than carbon fiber + quartz and quartz fiber dowels. Titanium dowels with a composite build-up are better (moderately) than gold alloy cast dowels.

Conclusions: According to the studies of the highest levels of evidence, carbon fiber in resin matrix dowels are significantly better than precious alloy cast dowels (RCT). Glass fiber dowels are significantly better than metal screw dowels (RCT) and moderately better than quartz fiber dowels (CCT). Carbon fiber dowels are significantly worse than metal dowels (of precious alloy) (RCT). Prefabricated metal dowels are slightly better than cast dowels (RCT), but moderately worse when no collar of the dentin above the gingiva could be achieved (CCT).

The purpose of this study was to compare different dowel and core materials based on the available clinical trials of the highest level of evidence. The analysis was limited to levels 1 to 3 of clinical evidence, because these levels are able to demonstrate causality. Controlled clinical trials, randomized or not (level 1), cohort studies (level 2), and case control studies (level 3) always have at least two similar though separate groups to test. Of those, one would be the experimental and the other the control group of the study. Their methodology incorporates a comparison, which makes them more powerful and worthy of credit.

The reconstruction of endodontically treated teeth is frequently required before the definitive restoration can be

accomplished, especially when the remaining coronal tooth structure is inadequate to provide retention and resistance form for the restoration. Selection of the most suitable dowel and core system is challenging, and a number of different techniques and materials are used for this purpose in clinical practice.

Recently, the esthetic performance of systems has become important, as has ease of manipulation during the application of the various dowel and core systems. Nevertheless, strength and reliability of a system are always important. Materials or combinations of materials with such properties used in vivo could be identified only through the results extrapolated by clinical trials with a high level of evidence.

A systematic review conducted by Bolla[1] for the Cochrane Database for Systematic Reviews on the effectiveness of different types of dowels identified two randomized controlled clinical trials (RCTs) (of which only one was related to the objective of the current review), and one of the conclusions was that more RCTs are needed to confirm whether fiber-reinforced dowel and core systems are superior to metal dowels. On the completion of the search of this current review, additional RCTs have been identified. These are included in this study and, we believe, the results and the conclusion add details to the field.

Materials and methods

Literature search

One electronic search of MEDLINE (Table 1), from 1966 to January 2008, one Cochrane (Table 2), and one EMBASE search from 1945 to January 2008 (Table 3) were conducted.

Inclusion criteria validity

Two independent reviewers examined all identified abstracts to determine whether they met the following criteria:

Table 1 MEDLINE search strategy

No.	Search history	Results
1	Post	340,716
2	Core	107,877
3	Dowel	546
4	Cement	17,425
5	Dentin	18,818
6	Failure	434,087
7	Fracture	141,267
8	1 or 2 or 3 or 4 or 5 or 6 or 7	1,013,038
9	Root canal therapy	13,880
10	Post and core*	6,128
11	Endodontically treated teeth	1,133
12	9 or 10 or 11	19,467
13	8 and 12	8,944
14	Limit 13 to humans, English, French, German, Greek, Modern	5,956 5,956
15	14 and patients	997

Table 2 Cochrane Library search strategy

No.	Search history	Results
1	Post	30,228
2	Core	2,968
3	Dowel	35
4	Cement	1,795
5	Dentin	1,319
6	Failure	29,760
7	Fracture	5,721
8	1 or 2 or 3 or 4 or 5 or 6 or 7	65,130
9	Root canal therapy	360
10	Post and core	569
11	Endodontically treated teeth	78
12	9 or 10 or 11	912
13	8 and 12	699
14	13 and patient*	448
15	Limit, from 1966 to 2008	141

1. Study in vivo
2. Conducted in humans
3. Related to the question
4. Experimental and control group
5. Quantitative results provided
6. English, German, French languages.

Whenever it was not possible to make this determination, the full-text article was examined. Subsequently, all relevant articles were obtained, and a determination was made by two reviewers if they met the inclusion criteria.

All articles were classified as levels of evidence (Table 4) (EBM://cebm.jr2.ox.uk/docs/levels.html) and then

Table 3 EMBASE search strategy

No.	Search history	Results
1	Post	293,408
2	Core	87,863
3	Dowel	239
4	Cement	14,114
5	Failure	468,147
6	Fracture	126,663
7	1 or 2 or 3 or 4 or 5 or 6	952,423
8	Tooth	56,698
9	Teeth	19,862
10	Dent*	76,189
11	Endodont*	1,342
12	8 or 9 or 10 or 11	107,210
13	Endodontically treated teeth	51
14	Post and core)	2,286
15	13 or 14	2,335
16	7 and 12 and 15	59
17	Limit 16 to human	31
18	Limit 17 to (English or French or German or Greek)	25
19	Limit 18 to year = "1945 to 2007"	25

Table 4 Levels of clinical evidence*

Level of evidence	Study type	No.
1A	Randomized control trial (RCT)	6
	Systematic review of RCTs	
1B	Controlled clinical trial (CCT)	2
	Systematic review of CCTs	
2	Cohort study (CS)	2
	Systematic review of CSs	
3	Case control study (CCS)	0
	Systematic review of CCSs	
4	Case series	0
5	Expert's opinion	0
	Narrative review	
NA	Cross sectional	0
	Case reports	
	Animal studies	
	Laboratory studies	
Nonvalidated	Because of language limitations	0

*http://www.cebm.net/index.aspx?o=1025

assessed for validity (Table 5) (http://www.cebm.utoronto.ca/teach/materials/therapy.htm).

Clinical applicability

The number needed to treat (NNT) was calculated using Guyatt et al's[2] method. For this study, NNT is defined as the number of teeth that would need to be restored with the experimental material, in order to have a successful result to one more tooth (NNT: 1), or a harmful result to one more tooth (NNT: −1), when compared with the result after the use of the control material. The closer the value of NNT is to 1, the greater the positive or negative clinical effect of the new material. A result is considered successful when the tested dowel system remains intact and well cemented in the root canal, the root of the tooth remains intact, and no periapical lesion has developed during the examination period.

Table 5 Validity assessment criteria*

1. Was the assignment of treatment patients randomized?
2. Was the randomization list concealed?
3. Was the follow-up of patients sufficiently long and complete?
4. Were all patients analyzed in the groups to which they were randomized?
5. Were patients and clinicians blinded to the treatment being received?
6. Aside from the experimental treatment, were the groups treated equally?
7. Were the groups similar at the start of the trial?

*Sackett DL, Straus SE, Richardson WS, et al: Evidence-Based Medicine. How to Practice and Teach EBM (ed 2). Edinburgh, UK, Churchill Livingstone, 2000.

Confidence intervals (CI) were calculated using the following equation:

$$\mathrm{CI}(95\%) = \pm 1.96 \sqrt{\left(\frac{\mathrm{CER}(1-\mathrm{CER})}{\text{number of control teeth}}\right) + \left(\frac{\mathrm{EER}(1-\mathrm{EER})}{\text{number of experimental teeth}}\right)}.$$

Results

MEDLINE search

The MEDLINE search from 1966 to January 2008 identified 997 articles (Fig 1). From 997 articles identified by the search, the hand examination of titles, abstracts, and full-text articles revealed that 954 were irrelevant, and 43 appeared to be relevant. Of the 43 articles, 4 were in vitro studies, 2 were narrative reviews, and the remaining 37 were relevant in vivo studies.

Of the 37 relevant studies on humans,

- seven were excluded[3-9] because they had neither experimental and control group nor quantitative results (Table 6);
- fourteen of those studies[10-23] did not have experimental and control groups (Table 6);
- three[24-26] did not provide quantitative results (Table 6);
- from the remaining 13 articles, 3[27-29] were excluded because they met fewer than five of the seven validity criteria (Table 7);
- ten articles[30-39] were finally included. Their details are presented in Tables 8–13.

Cochrane Library search

The Cochrane search identified 141 articles. From 141 articles identified by the search, the hand examination of titles, abstracts, and full-text articles revealed that 132 were irrelevant to the question, and 9 appeared to be relevant. Of the nine articles, two were in vitro studies and the remaining seven were relevant in vivo studies (Fig 1).

All of the seven relevant studies on humans were also identified by the Medline search (above) and met all the inclusion criteria and five or more of the validity assessment criteria (Tables 6 and 7).

EMBASE search

The EMBASE search from 1945 to January 2008 identified 25 articles. From 25 articles identified by the search, the hand examination of titles, abstracts, and full-text articles revealed that 11 were irrelevant and 14 appeared to be relevant. Of these 14 articles, 8 were in vitro studies, 2 were narrative reviews,[40,41] 1 was a case report,[42] and the remaining 3 were relevant in vivo studies (Fig 1).

Of the three relevant studies on humans,

- two were excluded[3,9] because they had neither experimental and control groups nor quantitative results (Table 6).
- The third study[23] was also excluded because it did not have experimental and control groups (Table 6).

To calculate the NNT (number needed to treat) for each study, for each group the following was considered:

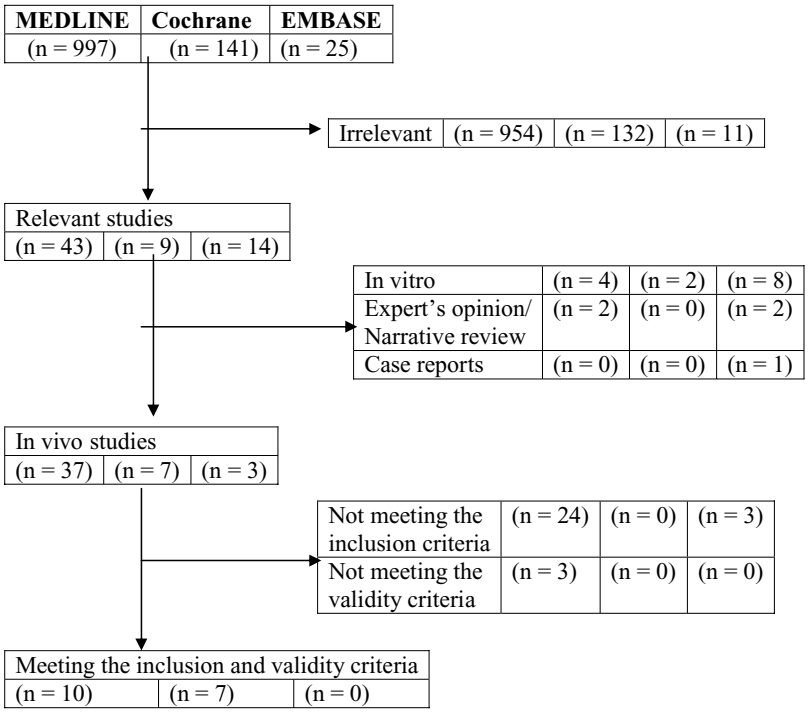

Figure 1 Search results.

"Failures" were considered as cases with root fracture, dowel fracture, periapical radiographic change/lesion, and/or dowel dislodgment.

"No Change" was considered as cases with no caries, periodontal change/disease, dislodgment of the crown and/or core, or any damage to the crown and/or the core.

Analysis of the results of the randomized controlled clinical trials (RCT)

Cast dowels (precious alloy) as a control group were compared as dowel materials to carbon fiber in an epoxy resin matrix dowels (Composipost® or C-post®, Recherches Techniques Denraires, St. Egrève, France) as an experimental group.[33] The NNT calculated was 8.30 (CI 95% = ±0.073), suggesting that carbon fiber in resin matrix dowels are significantly better than cast dowels (Tables 8 and 11).

Gold alloy cast dowels (ParaPost® system, Coltene Whaledent Inc., Cuyahoga Falls, OH) as a control group were compared to gold alloy cast dowels and to prefabricated dowels (ParaPost®, gold alloy) as experimental groups.[31] The NNTs calculated were 13.15 (CI 95% = ±0.145) and 175.4 (CI 95% = ±0.2), respectively. These results suggest that gold alloy cast dowels are better than gold alloy cast dowels (ParaPost®), while the gold alloy prefabricated dowels (ParaPost®) are slightly better than the gold alloy cast dowels (ParaPost®) (Tables 8, 11).

Glass fiber-reinforced dowels as an experimental group were compared to metal screw dowels as a control group.[39] The NNT was 5.46 (CI 95% = ±0.14), suggesting that glass fiber dowels are significantly better than metal screw dowels (Tables 8 and 11).

Metal dowels (of precious alloy) as a control group were compared to carbon fiber-reinforced dowels as an experimental group[38] and the NNT calculated was −5.81 (CI 95% = ±0.31). This study indicates that precious alloy dowels are significantly better than carbon fiber-reinforced dowels (Tables 8 and 11).

Glass fiber dowels as the experimental group were compared to metal-titanium dowels as the control group.[37] The NNT calculated was −21.73 (CI 95% = ±0.06). This indicates that titanium dowels show better success rates than glass fiber dowels (Tables 8 and 11).

Carbon fiber dowels as an experimental group were compared to amalgam (control group).[36] The NNT was −125 (CI 95% = ±0.08), suggesting that amalgam is slightly better than fiber dowels (Tables 8 and 11).

Analysis of the results of the nonrandomized controlled clinical trials (CCT)

Cast dowels as the control group were compared to metal dowels (experimental group) in two trials by the same group of researchers.[30] At the first trial, less than 25% of the circumferential dentin wall of the teeth had less than 1 mm above the gingiva, but a collar of 1 to 2 mm could be achieved. At the second trial, more than 25% of the circumference had less than 1 mm above the gingiva, or no collar of 1 to 2 mm could be achieved. In the first trial, metal dowels showed less failure than the cast dowels, as indicated by the NNT calculated (NNT = 21.73, CI 95% = ±0.062), and in the second trial, metal

Table 6 Inclusion criteria application

References	1	2	3	4	5	6
Piovesan et al 2007[21]	Y	Y	Y	N	Y	Y
Naumann et al 2007[38]*	Y	Y	Y	Y	Y	Y
Fokkinga et al 2007[24]	Y	Y	Y	Y	N	Y
Cagidiaco et al 2007[12]	Y	Y	Y	N	Y	Y
Schmitter et al 2007[39]*	Y	Y	Y	Y	Y	Y
Miyamoto et al 2007[19]	Y	Y	Y	N	Y	Y
Jung et al 2007[34]	Y	Y	Y	Y	Y	Y
Al-Hamad et al 2006[3]*	Y	Y	Y	N	N	Y
Balkenhol et al 2007[10]	Y	Y	Y	N	Y	Y
Zhang et al 2006[9]**	Y	Y	Y	N	N	Y
Segerström et al 2006[7]	Y	Y	Y	N	N	Y
Nothdurft et al 2006[20]	Y	Y	Y	N	Y	Y
Naumann et al 2005[25]	Y	Y	Y	Y	N	Y
Grandini et al 2005[13]	Y	Y	Y	N	Y	Y
Willershausen et al 2005[23]**	Y	Y	Y	N	Y	Y
Naumann et al 2005[26]	Y	Y	Y	Y	N	Y
Mannocci et al 2005[36]*	Y	Y	Y	Y	Y	Y
Creugers et al 2005[30]*	Y	Y	Y	Y	Y	Y
Paul and Werder 2004[28]	Y	Y	Y	Y	Y	Y
Fox et al 2004[4]	Y	Y	Y	N	N	Y
Monticelli et al 2003[37]*	Y	Y	Y	Y	Y	Y
Hedlund et al 2003[14]	Y	Y	Y	N	Y	Y
King et al 2003[35]*	Y	Y	Y	Y	Y	Y
Ellner et al 2003[31]*	Y	Y	Y	Y	Y	Y
Malferrari et al 2003[16]	Y	Y	Y	N	Y	Y
Iqbal et al 2003[15]	Y	Y	Y	N	Y	Y
Ferrari, Vichi, Mannocci 2000[32]	Y	Y	Y	Y	Y	Y
Ferrari, Vichi, García-Godoy 2000[33]	Y	Y	Y	Y	Y	Y
von Krammer et al 2000[8]	Y	Y	Y	N	N	Y
Glazer 2000[6]	Y	Y	Y	N	N	Y
Fredriksson et al 1998[5]	Y	Y	Y	N	N	Y
Torbjörner et al 1995[29]	Y	Y	Y	Y	Y	Y
Mentink, Creugers et al 1993[17]	Y	Y	Y	N	Y	Y
Mentink, Meeuwissen, et al 1993[18]	Y	Y	Y	N	Y	Y
Hatzikyriakos et al 1992[27]	Y	Y	Y	Y	Y	Y
Weine et al 1991[22]	Y	Y	Y	N	Y	Y
Bergman et al 1989[11]	Y	Y	Y	N	Y	Y

*Also identified in Cochrane Library search.

**Also identified in EMBASE search.

Table 7 Validity assessment criteria application

References	1	2	3	4	5	6	7
Naumann et al 2007[38]*	Y	Y	Y	Y	N	Y	Y
Schmitter et al 2007[39]*	Y	Y	Y	Y	N	N	Y
Jung et al 2007[34]	Y	Y	Y	N	N	Y	Y
Mannocci et al 2005[36]*	Y	Y	Y	Y	Y	Y	Y
Creugers et al 2005[30]*	Y	Y	Y	Y	Y	Y	Y
Paul and Werder 2004[28]	N	N	Y	N	N	Y	Y
Monticelli et al 2003[37]*	Y	Y	Y	Y	Y	Y	Y
King et al 2003[35]*	Y	N	Y	Y	Y	Y	Y
Ellner et al 2003[31]*	Y	Y	Y	Y	Y	Y	Y
Ferrari , Vichi , Mannocci 2000[32]	Y	N	Y	Y	N	Y	Y
Ferrari , Vichi , García-Godoy 2000[33]	Y	N	Y	Y	Y	Y	Y
Torbjörner et al 1995[29]	N	N	Y	Y	N	Y	Y
Hatzikyriakos et al 1992[27]	N	N	Y	N	N	N	Y

*Also identified in Cochrane search.

dowels showed more failure (NNT = −33.33, CI 95% = ±0.062) (Table 9 and 12).

Glass fiber-reinforced dowels (Postec® posts, Ivoclar-Vivadent, Schaan, Liechtenstein) as control group were compared to two different quartz fiber dowels; DT® posts (Bisco, Schaumburg, IL) and AEstheti-plus® posts (Bisco) (experimental groups), by the same group of researchers.[37] When the glass fiber dowels (Postec®) as the control group were compared to quartz fiber (DT®) dowels, the NNT could not be calculated (NNT = 1/0, CI 95% = ±0.072), because both groups had the same success rate. When glass fiber dowels (Postec®) were compared to quartz fiber dowels (AEstheti-plus®), the NNT was −37.03 (CI 95% = ±0.08), suggesting that the glass fiber-reinforced dowels have fewer failures than quartz fiber (AEstheti-plus®) dowels in restoring the endodontically treated teeth (Tables 9 and 12).

Analysis of the results of the cohort studies (CS)

Ferrari et al[32] compared carbon fiber in resin matrix dowels (Composipost® or C-post®) as the experimental group to carbon fiber + quartz dowels (AEstheti® posts)[32] and to quartz fiber dowels (AEstheti-Plus® posts)[32] as the control groups. The NNTs calculated were positive for both comparisons: 90.90 (CI 95% = ±0.027) and 55.55 (CI 95% = ±0.027), respectively (Tables 10 and 13). This suggests that Composiposts® provide better success rates (moderately) than carbon fiber + quartz dowels (AEstheti) and quartz fiber dowels (AEstheti-Plus) (Tables 10 and 13).

Jung et al[34] compared metal-titanium dowels to gold alloy cast dowels[34] (control group), and the NNT calculated was 66.66 (CI 95% = ±0.21). This suggests that titanium dowels provide better success rates (moderately) than gold alloy cast dowels (Tables 10 and 13).

Discussion

Various materials and techniques are being used to restore the abutment. Cast dowels, especially those made of precious/gold alloys, have been widely used for many years. Additionally, prefabricated dowels cemented with various cements have been used in recent decades. Recently, carbon or glass fiber-reinforced or nonreinforced dowels have been used as well to achieve better bonding with dentin and improved esthetics.

While prefabricated dowels of all types (metal, titanium, fiber) are easier to use, the conventional cast dowel fabrication and application techniques are time consuming. Time needed for preparation and application and esthetic performance have become important issues in daily practice; however, the strength and reliability of the system used are even more important. So, today's dilemma would be which material or combination of materials is the most efficient concerning strength and reliability, esthetics, and ease of manipulation. With this in mind, and in order to identify, if possible, the most effective material

Table 8 Results of the randomized controlled clinical trials (RCT)

Reference	Control group	Experimental group	Nc/Ne	Duration	Success (C/E)	Failure (C/E)	Uncertain/no improvement (C/E)
Ferrari et al 2000[33]	Cast dowels (precious alloy)	Carbon fiber in resin matrix dowel (C-Post®)	98/97	48 months	84/95	12/2	2/0
Ellner et al 2003[31]	Cast dowels (ParaPost® system, gold alloy)	Cast dowels (gold alloy)	13/14	109 months	12/14	1/0	0/0
Ellner et al 2003[31]	Cast dowels (ParaPost® system, gold alloy)	Metal dowels (ParaPost® prefabricated, gold alloy)	13/13	109 months	12/12	1/0	0/1
Schmitter et al 2007[39]	Metal screw dowels	Glass fiber dowels (reinforced)	45/46	24 months	34/43	10/2	1/1
King et al 2003[35]	Metal dowels (precious alloy)	Carbon fiber dowels (reinforced)	9/14	87 months	8/10	1/4	0/0
Naumann et al 2007[38]	Metal dowels (titanium)	Glass fiber dowels	46/43	36 months	46/41	0/0	0/2
Mannocci et al 2005[36]	Amalgam	Carbon fiber dowels	100/97	60 months	91/87	6/0	3/10

Nc = number of controls; Ne = number of experiments.

or combination of materials to restore endodontically treated teeth to be used as abutments, we conducted this systematic review.

A systematic review had already been conducted by Bolla et al[1] for the Cochrane Database for Systematic Reviews to assess the effectiveness of different dowel and core systems for the restoration of endodontically treated teeth. The primary objective of that review was to compare the clinical failure rates of the different types of dowels. The review identified two RCTs, and of those, only one compared metal to nonmetal dowels. An additional conclusion was that more RCTs were needed to confirm whether fiber-reinforced dowel and core systems are superior to metal dowels.

We identified and examined clinical trials of high levels of evidence that tested at least two different dowels, or dowel and core material combinations, in order to have the most objective results possible.

After a detailed literature search, six RCT studies, two CCT, and two CS studies were identified. In the process of calculating the NNTs, several times we changed the position of the materials examined from the experimental to the control group site and vice versa. We finally decided to present the materials in order to have at the same group site the same or similar materials and to afford easier comparisons and result extrapolations.

The available in vivo human trials as identified from this current review suggest the following (Tables 8–13):

1. Carbon fiber in resin matrix dowels (Composiposts®) show better success rates than precious alloy cast dowels (significantly) [one study (RCT); 97/98 teeth respectively, 4-year duration].[33] They are also better (moderately) than quartz fiber (AEstheti-plus®) [one study (CS); 840/249 teeth, respectively, ≈2-year duration][32] and carbon fiber + quartz dowels (AEstheti®) [one study (CS); 840/215 teeth, respectively, ≈2-year duration].[31]
2. Gold alloy tapered cast dowels are better than ParaPost® gold alloy cast dowels [one study (RCT); 14/13 teeth respectively, >9-year duration].[31]
3. Prefabricated dowels of gold alloy (ParaPost®) are slightly better than ParaPost® gold alloy cast dowels [one study (RCT); 13/13 teeth, respectively, >9-year duration].[31] Metal dowels show better success rates than cast dowels when a collar of 1 to 2 mm could be achieved [one study (CCT); 90/69 teeth, respectively, 5-year duration),[30] but also more failures when no collar could be achieved [one study (CCT); 60/58 teeth, respectively, 5-year duration].[30] Titanium dowels with a composite build-up are better than gold alloy cast dowels (moderately) [one study (CS); 31/41 teeth, respectively, >8-year duration].[34]

Table 9 Results of the nonrandomized clinical trials (CCT)

Reference	Control group	Experimental group	Nc/Ne	Duration (months)	Success (C/E)	Failure (C/E)	Uncertain/no improvement (C/E)
Creugers et al 2005[30]	Cast dowels	Metal dowels	69/90	60	65/89	4/1	0/1
Creugers et al 2005[30]	Cast dowels	Metal dowels	58/60	60	55/55	3/1	0/4
Monticelli et al 2003[37]	Glass fiber-reinforced dowels (Postec®)	Quartz fiber dowels (D.T.®)	75/75	24	71/71	4/4	0/0
Monticelli et al 2003[37]	Glass fibe- reinforced dowels (Postec®)	Quartz fiber dowels (AEstheti- plus®)	75/75	24	71/69	4/6	0/0

Nc = number of controls; Ne = number of experiments.

Table 10 Results of the cohort studies (CS)

Reference	Control group	Experimental group	Nc/Ne	Duration (months)	Success (C/E)	Failure (C/E)	Uncertain/no improvement (C/E)
Ferrari et al 2000[32]	Carbon fiber + quartz dowels (AEstheti®)	Carbon fiber in resin matrix dowels (C-Post®)	215/ 840	14 to 46	207/818	8/22	8/0
Ferrari et al 2000[32]	Quartz fiber dowels (AEstheti-plus®)	Carbon fiber in resin matrix dowels (C-Post®)	249/ 840	13 to 46	238/818	11/22	0/0
Jung et al 2007[34]	Cast dowels (gold alloy)	Metal dowels (titanium)	41/31	102	25/19	8/5	8/7

Nc = number of controls; Ne = number of experiments.

Table 11 NNT* calculations of the randomized controlled clinical trials (RCT)

Reference	Control group	Experimental group	NNT	Confidence intervals (CI 95%)
Ferrari et al 2000[33]	Cast dowels (precious alloy)	Carbon fiber in resin matrix dowels (C-Post®)	8.30	±0.073
Ellner et al 2003[31]	Cast dowels (ParaPost® system, gold alloy)	Cast dowels (gold alloy)	13.15	±0.145
Ellner et al 2003[31]	Cast dowels (ParaPost® system, gold alloy)	Metal dowels (ParaPost® prefabricated, gold alloy)	175.4	±0.2
Schmitter et al 2007[39]	Metal screw dowels	Glass fiber dowels (reinforced)	5.46	±0.14
King et al 2003[35]	Metal dowels (precious alloy)	Carbon fiber dowel (reinforced)	−5.81	±0.31
Naumann et al 2007[38]	Metal dowels (titanium)	Glass fiber dowels	−21.73	±0.06
Mannocci et al 2005[36]	Amalgam	Carbon fiber dowels	−125	±0.08

*NNT: the number of teeth that would need to be restored with the experimental material, in order to have another success (or failure when NNT <1).

Table 12 NNT* calculations for nonrandomized clinical trials (CCT)

Reference	Control group	Experimental group	NNT	Confidence intervals (CI 95%)
Creugers et al 2005[30]	Cast dowels	Metal dowels	21.73	±0.062
Creugers et al 2005[30]	Cast dowels	Metal dowels	−33.33	±0.089
Monticelli et al 2003[37]	Glass fiber- reinforced dowels (Postec®)	Quartz fiber dowels (D.T.®)	1/0	±0.072
Monticelli et al 2003[37]	Glass fiber- reinforced dowels (Postec®)	Quartz fiber dowels (AEstheti-plus®)	−37.03	±0.08

*NNT: the number of teeth that would need to be restored with the experimental material, in order to have another success (or failure when NNT <1).

Table 13 NNT* calculations for the cohort studies (CS)

Reference	Control group	Experimental group	NNT	Confidence intervals (CI 95%)
Ferrari et al 2000[32]	Carbon fiber + quartz dowels (AEstheti®)	Carbon fiber in resin matrix dowels (C-Post®)	90.90	±0.027
Ferrari et al 2000[32]	Quartz fiber dowels (AEstheti-plus®)	Carbon fiber in resin matrix dowels (C-Post®)	55.55	±0.027
Jung et al 2007[34]	Cast dowels (gold alloy)	Metal dowels (titanium)	66.66	±0.21

*NNT: the number of teeth that would need to be restored with the experimental material, in order to have another success (or failure when NNT <1).

4. Glass fiber dowels are significantly better than metal screw dowels [one study (RCT); 46/45 teeth, respectively, 2-year duration][39] and glass fiber-reinforced dowels (Postec®) are better than quartz fiber dowels (AEstheti-plus®) [one study (CCT); 75/75 teeth, respectively, 2-year duration].[37] Glass fiber-reinforced dowels are moderately worse than titanium dowels [one study (RCT); 43/46 teeth, respectively, 3-year duration].[38] Furthermore, quartz fiber dowels (DT®) and glass fiber-reinforced dowels (Postec®) show the same results when compared to each other [one study (CCT); 75/75 teeth, respectively, 2-year duration], and the NNT = 1/0 could not be calculated.[37]
5. Carbon fiber dowels are significantly worse than metal dowels [one study (RCT); 9/14 teeth, respectively, >7-year duration][35] and slightly worse than amalgam dowels [one study (RCT); 97/100 teeth, respectively, 5-year duration].[36]

Conclusion

It seems that carbon fiber in resin matrix dowels are significantly better than precious alloy cast dowels (RCT). Glass fiber dowels are significantly better than metal screw dowels (RCT) and moderately better than quartz fiber dowels (CCT). Carbon fiber dowels are significantly worse than precious alloy metal dowels (RCT). Prefabricated metal dowels are slightly better than cast dowels (RCT), but moderately worse when no collar of the dentin above the gingiva could be achieved (CCT).

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