Effect of Smear Layer on Sealing Ability of Canal Obturation: A Systematic Review and Meta-analysis

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Abstract

The purpose of this systematic review was to determine whether smear layer removal reduces leakage of obturated human teeth in vitro. PubMed was searched for articles published between 1975 and 2005, and results were categorized based on the method of leakage test. Among 26 eligible papers with 65 comparisons, 53.8% of the comparisons reported no significant difference, 41.5% reported a difference in favor of removing the smear layer, and 4.7% reported a difference in favor of keeping it; differences were significant ($p < 0.001$). Of the 65 comparisons, 44 used the dye leakage test for evaluation. The combined effect in this group showed smear layer removal decreases dye leakage (z-score = 0.37, $z = 2.31$, $p = 0.021$). According to meta-regression, obturation type, test site and duration, sealer and dye, and publication year had no effect on the results. Under the conditions of these in vitro leakage studies, it is concluded that smear layer removal improves the fluid-tight seal of the root canal system whereas other factors such as the obturation technique or the sealer, did not produce significant effects. *(J Endod 2007;33: 96–105)*

Key Words

Canal seal, meta-analysis, obturation, smear layer, systematic review

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Although the smear layer was first identified and introduced 30 years ago (1), the question of keeping it during canal treatment is still in debate. It has been suggested by some authors that keeping the smear layer may block the dentinal tubules and limit bacterial or toxin penetration by altering the dentinal permeability (2–4). In contrast, some experts believe that the smear layer must be completely removed from the surface of the canal wall because it can harbor bacteria and can be detrimental to effective disinfection of dentinal tubules by preventing sodium hypochlorite, calcium hydroxide, and other intracanal medicaments from penetrating into the dentinal tubules; and it can act as a barrier between obturating materials and the canal wall and thus interfere with the formation of an appropriate seal (5–10).

It is known that one of the most important factors strongly affecting the prognosis of a root canal treatment is the canal seal, gained by appropriate obturation (11). Although a great deal of effort has been made to understand the effect of the smear layer on the apical or coronal seal (9, 12–36), the controversy of keeping or removing it still exists; thus, a systematic review to find the answer to this question seems necessary. In addition, our knowledge about the interactions between the smear layer and factors such as obturation technique and sealer type is very limited. Moreover, the methodology of studies, type and site of leakage tests, and the sample size should be taken into account, in our judgment.

Because of the aforementioned reasons, the purpose of this study was to systematically review the literature to determine whether smear layer removal reduces leakage of extracted human teeth obturated with gutta-percha with different sealers in vitro.

Materials and Methods

A comprehensive search was initiated to identify studies on the subject published in English from January 1975 to January 2005, using the PubMed service of the National Library of Medicine and the U.S. National Institutes of Health. Different combinations of the following key words were used in search queries: endodontics, smear layer, leakage, and root canal. Using this method, 145 abstracts were primarily selected for review (Table 1).

The inclusion criteria were (a) relevance of the contents to the subject of this review (for example, the article of Arisu et al. (37) was among the primarily selected articles that were considered irrelevant, because it actually reported the effects of a type of laser on the morphology and permeability of apical dentin surfaces, which is not related to our research, and the article of Ozturk (41) was considered irrelevant because it evaluated the effects of dentinal adhesive systems on pulp chamber seal); (b) availability of the full-text version of the abstract; (c) presentation of experimental research; (d) use of extracted human teeth as samples; (e) use of gutta-percha as the obturating material; (f) inclusion of two groups in the research design, one group with smear layer and the other without it; and (g) presentation of data reporting a valid mean and standard deviation (SD).

Considering these criteria, 98 papers were excluded from the study, and 47 articles were selected, photocopied, and reviewed by two endodontists. The reference section of each of these articles then was studied to determine whether any of the references cited in the article matched our search criteria. The ones that matched were placed on a master list, and each time a reference section was reviewed, the references were checked against the master list. If the article did not appear on the master list, it was then located, reviewed, and cross-referenced. This exhaustive process of locating,

TABLE 1. Research articles primarily reviewed in this meta-analysis

No.	Author (ref. no.)	Year	Inclusion Criteria Met	Test Type
1	Arisu et al. (37)	2004	No	—
2	Behr et al. (38)	2004	No	—
3	Carrotte (39)	2004	No	—
4	Cobankara et al. (21)	2004	Yes	Fluid filtration
5	Economides et al. (12)	2004	Yes	Fluid filtration
6	Karadag et al. (40)	2004	No	—
7	Ozturk et al. (41)	2004	No	—
8	Park et al. (31)	2004	Yes	Dye leakage
9	Prati et al. (42)	2004	No	—
10	Sevimay et al. (43)	2004	No	—
11	Clark-Holke et al. (22)	2003	Yes	Bacterial penetration
12	Davis et al. (44)	2003	No	—
13	Ferrari and Tay (45)	2003	No	—
14	Hossain et al. (46)	2003	No	—
15	Al-Turki and Akpata (47)	2002	No	—
16	De la Macorra and Escribano (48)	2002	No	—
17	Moodley and Grobler (49)	2002	No	—
18	Murray et al. (50)	2002	No	—
19	Shigetani et al. (51)	2002	No	—
20	Tay et al. (52)	2002	No	—
21	Tay et al. (53)	2002	No	—
22	Tay et al. (54)	2002	No	—
23	Torabinejad et al. (55)	2002	No	—
24	Wimonchit et al. (56)	2002	No	—
25	Yang and Bae (5)	2002	No	—
26	Cox et al. (57)	2001	No	—
27	Gilbert et al. (58)	2001	No	—
28	Gilhooly et al. (59)	2001	No	—
29	Kubo et al. (60)	2001	No	—
30	Ozok et al. (61)	2001	No	—
31	Timpawat et al. (20)	2001	Yes	Fluid filtration
32	Al-Dewani et al. (62)	2000	No	—
33	Al-Dewani et al. (63)	2000	No	—
34	Ferrari et al. (64)	2000	No	—
35	Von Fraunhofer et al. (34)	2000	Yes	Electrochemical
36	Froes et al. (23)	2000	Yes	Dye leakage
37	Goya et al. (33)	2000	No	Dye leakage
38	Al-Jazairy and Louka (65)	1999	No	—
39	Davalou et al. (66)	1999	No	—
40	Economides et al. (19)	1999	Yes	Electrochemical
41	Kimura et al. (67)	1999	No	—
42	Kytridou et al. (68)	1999	No	—
43	Mannocci et al. (69)	1999	No	—
44	Yamazaki et al. (70)	1999	No	—
45	Barkhordar and Russel (71)	1998	No	—
46	Caliskan et al. (72)	1998	No	—
47	Santini (73)	1998	No	—
48	Sen and Buyukyilmaz (74)	1998	No	—
49	Timpawat and Sripanaratanakul (29)	1998	Yes	Dye leakage
50	Wu et al. (75)	1998	No	—
51	Youngson et al. (76)	1998	No	—
52	Pashley and Carvalho (77)	1997	No	—
53	Saunders and Saunders (78)	1997	No	—
54	Taylor et al. (18)	1997	Yes	Dye leakage
55	Behrend et al. (25)	1996	Yes	Bacterial penetration
56	Brannstrom (79)	1996	No	—
57	Chailertvanitkul et al. (24)	1996	Yes	Bacterial penetration
58	Leonard et al. (80)	1996	No	—
59	Meiers and Kresin (81)	1996	No	—
60	Perez et al. (82)	1996	No	—
61	Sen et al. (83)	1996	No	—
62	Vassiliadis et al. (16)	1996	Yes	Dye leakage
63	Zoellner et al. (84)	1996	No	—
64	Yap et al. (85)	1996	No	—
65	Goldberg et al. (26)	1995	Yes	Dye leakage
66	Hasegawa et al. (86)	1995	No	—
67	Lioyd et al. (30)	1995	No	Dye leakage
68	Sen et al. (87)	1995	No	—
69	Sultan and Pitt Ford (88)	1995	No	—
70	Trowbridge (89)	1995	No	—
71	Chigira et al. (90)	1994	No	—
72	De Gee et al. (91)	1994	No	—
73	Gaintanzopoulou et al. (92)	1994	No	—
74	Karagoz-Kucukay and Bayirli (17)	1994	Yes	Electrochemical