Outcome of Root Canal Obturation by Warm Gutta-Percha versus Cold Lateral Condensation: A Meta-analysis

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Abstract

The purpose of this study was to evaluate clinical outcome differences of root canal obturation by warm gutta-percha (GP) or cold lateral condensation (CLC) through a systematic review and meta-analysis. There were 10 clinical studies evaluated. Postoperative pain, long-term outcomes, obturation quality, and overextension were the characteristics investigated. The results suggest that the two obturation techniques are not significantly different except in overextention. The relative risk (RR) value of warm GP versus CLC and 95% confidence interval (CI) of the first three criteria were 1.10 (0.71, 1.71), 0.78 (0.58, 1.05), and 1.31 (0.98, 1.76), respectively. Overextension was more likely to occur in the warm GP obturation group in comparison with the CLC group. The RR value and 95% CI were 1.98 (1.33, 2.93). In conclusion, warm GP obturation demonstrated a higher rate of overextension than CLC. Postoperative pain prevalence, long-term outcomes, and obturation quality were similar between the two groups. *(J Endod 2007;33:106–109)*

Key Words

Cold lateral condensation, meta-analysis, root canal obturation, warm gutta-percha.

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The function of root canal obturation is to fill the root canal space and eliminate all portals of entry between the canal and the periodontium. The better the seal, the better the prognosis for the tooth. An ideal filling should be well condensed, seal all foramina leading to the periodontium, adapt to the instrumented canal walls, and end at the apical seat (1, 2).

Cold lateral condensation (CLC) as an obturation technique is widely applied by dental practitioners throughout the world because of its advantages of controlled placement of gutta-percha (GP) in the root canal and low cost (3–5). The final filling is composed of a large number of GP cones tightly pressed together and joined by frictional grip and cementing substance, rather than a homogeneous mass of GP (2). Voids because of spaces between individual GP cones and the root canal walls can be seen with poor root canal preparation, curved canals, inadequate lateral pressure during condensation, or mismatches between GP cones and the prepared root canal. The resulting fill in such cases would lack homogeneity and have to rely on sealer to fill the voids, and thus would have a poorer prognosis (6, 7).

Compared with CLC, warm vertical condensation of GP can provide a high-density filling and better sealing at all portals of entry between the root canal and the periodontium (8, 9). This technique allows the placement of a homogeneous mass of GP into the canal system with the carrier as a means of compaction (10). This technique can be more effective in filling lateral canals than CLC (11). In clinical practice, the disadvantage of this technique is that the filling length is hard to control. Rapid insertion is related to overextension, whereas slow insertion tends to result in underfilling (4). On the basis of microscopic analysis and clinical tests, it has been concluded that optimum filling is achieved when canals are instrumented and filled 0.5 to 2.0 mm short of the root apex (12–15).

Though a great number of in vitro studies were conducted to compare the outcome of root canal obturation by warm GP with that by CLC, conclusions were inconsistent or contradictory, and less pertinent than clinical studies.

Randomized clinical trials (RCTs), in which participants are randomly assigned to treatment and control groups, are considered the gold standard of experimental design (16). Arch Cochrane (17), a British epidemiologist and therapist, recommended aggregating these individual results and performing a strict systematic review so as to come to a true and reliable conclusion. The Centre for Evidence Based Medicine (18) identifies RCTs and systematic reviews of RCTs as Level 1 according to the levels of evidence (LOE) corresponding to study design (19). Meta-analysis is a statistical procedure that integrates the results of several independent studies considered to be combinable (20). Well-conducted meta-analyses allow a more objective appraisal of the evidence than traditional narrative reviews, provide a more precise estimate of a treatment effect, and may explain heterogeneity between the results of individual studies (21, 22). Systematic reviews with meta-analysis are the only way to provide more practical and reliable suggestions and information for clinical practice when few clinical studies exist.

Materials and Methods

Literature Search

A computerized literature search was performed in MEDLINE (1966–2006), The Cochrane Library (Issue 4, 2005), EMBASE (1984–2006), SCI (1995–2006), and CNKI (1994–2006). Randomized controlled trials and controlled clinical trials comparing obturation by warm GP versus CLC conducted in humans were identified. The

clinical trials identified included those published up to April 2006 with the following MeSH terms and/or text words in various combinations: endodontics, root canal therapy, therm$ (use "$" for truncation), condensation, compaction, obturation, filling, lateral, vertical, warm, high temperature, low temperature, and GP. A number of useful references and optimum search strategies were received from the Cochrane Handbook for Systematic Reviews of Interventions (23). The title and abstract of all potentially relevant studies were identified for their relevance before retrieval of full articles. Full articles were also scrutinized for relevance if the title and abstract were ambiguous.

Inclusion and Exclusion

The majority of relevant studies were conducted in extracted teeth or in a simulated model. Although all the studies conducted in vitro were excluded, the articles mentioned in reference lists and their authors' relevant literature were scanned for further strict identification. The inclusion criteria were as follows: (a) the teeth were under endodontic treatment for irreversible pulp disease or chronic apical periodontitis; (b) all the selected teeth had not received any root canal treatment previously; (c) the outcome was evaluated by clinical symptoms and/or radiographic evidence. The exclusion criteria included the following: (a) the studies were not RCTs or preliminary quasi-RCTs; (b) studies were carried out in vitro or on retreatment cases; (c) the studies included no comparison between warm GP and CLC filling techniques; (d) no healing rate was presented; (e) the full text could not be located. All searches were conducted independently by at least two reviewers.

Data Extraction and Quality Assessment

The data on root canal obturation using warm GP versus CLC in terms of postoperative pain, long-term outcome, obturation quality, and rate of overextension were extracted from each study independently and entered into a computerized database. The extracted information of each study also included the name of the first author, year of publication, mean age for all case and control subjects, number of cases, number of controls, follow-up years, and loss of follow-up. Differences in interpreted data were resolved by discussion to reach consensus between the reviewers. According to the principles and procedures of meta-analysis (18), the qualities of 10 qualified studies were scored by a series of validity criteria according to Jadad et al's scale, respectively (24). Two independent readers blinded to the identity of the authors and their institutions and journal names were asked to evaluate the quality of the studies. The criteria for quality were based on the following: (a) Was the study described as randomized? (b) Was the study described as double-blind? (c) Was there a description of withdrawals and dropouts? The scores ranged from 0 to 2 for the first two questions and 0 to 1 for the last question. Studies with higher scores were weighted more when the meta-analysis was performed.

Definitions for Success and Failure

Postoperative pain defined flare-up as moderate to severe postoperative pain or moderate to severe swelling that began 12 to 48 hours after treatment and lasted at least 48 hours (25). A treatment failure was recorded if the tooth was extracted or symptomatic, or was associated with apical periodontitis at evaluation (26). The rate of overextension with warm GP versus CLC was analyzed. The distance between the root apex and the end of GP was used as the assessment index. A compact filling ending less than 2 mm short of the root apex was regarded as flush. Overextension was defined as a fill past the root apex (27).

Meta-Analysis

Meta-analysis was conducted with the help of RevMan 4.2.8 software provided by The Cochrance Collaboration (http://www.cochrane.de/original/cochrane/download.htm#REVM). Relative risk (RR) value of warm GP versus CLC and 95% CI (confidence interval) were calculated using raw dichotomous data of the selected studies. In systematic reviews, heterogeneity refers to variability or differences between studies in the estimates of effects. Statistical tests of heterogeneity were used to assess whether the observed variability in study results (effect sizes) was greater than that expected to occur by chance. The heterogeneity between studies was assessed using a Q statistic test. Fixed effects models consider only within-study variability. The assumption is that studies using identical methods, patients, and measurements should produce identical results; and that differences are only because of within-study variation. Random effects models consider both between-study and within-study variability. The assumption is that studies are a random sample from the universe of all possible studies (21, 22). If homogeneity existed among the studies ($p \geq 0.1$), the fix effect model (Peto method) was applied to aggregate the data. If the homogeneity was rejected ($p < 0.1$), then sensitivity analysis was performed to evaluate whether exclusion of one or more studies substantially reduced the heterogeneity or a random effect model (D-L method) was the option. If heterogeneity was still evident, descriptive statistics were given. In the presence of statistical heterogeneity, the sources of any possible heterogeneity were searched in terms of differences in assessment methods, clinical conditions, methodological, or biological heterogeneity.

Results

Study Selection and Data Summary

Twenty-one papers were initially reviewed but 11 were excluded. Ten articles met inclusion criteria (1, 26–34). Comparison of these 10 studies is shown in Table 1.

Meta-Analysis

The meta-analysis data summary for outcomes of root canal obturation using warm GP versus CLC in terms of postoperative pain prevalence, long-term outcome, obturation quality, and rate of overextension is shown in Table 2. The prevalence of overextension in the warm GP group was significantly higher than that in the CLC group ($p = 0.0007$). Other assessment items did not show statistical differences between the two obturation techniques.

Discussion

Laboratory studies greatly outnumber clinical studies. Reasons for this include the fact that it is easier and more objective for the researcher to evaluate obturation outcomes in terms of sealing ability, filling length, adaptation of GP, and canal space obturated in the extracted teeth or a simulated model than in the patient's mouth. Secondly, clinical trials are demanding of strict design, time and energy consuming, and difficult to perform; long-term follow-up is required, and assessment is more complicated. Still, clinical trials provide more useful information and practical suggestions, especially well-designed RCTs. Study design, level of blinding, randomization, patient selection, and definition of healing or failure must be planned carefully before starting a clinical trial. Of the 10 studies included in this systematic analysis, only 2 studies applied the blinding method in the outcome assessment. Nine of 10 studies mentioned the randomization method in the distribution of cases, but none of them stressed the allocation concealment. None of these papers reported rationale for the sample size. Randomization, as well as blinding, make groups comparable and minimize bias and confounding factors only when subjects are allocated in a genuine randomization manner (18, 35). To improve the quality of reports of RCTs and the efficiency of meta-analysis in medicine, it is suggested that reporting

TABLE 1. Comparison of the 10 studies that were used in the meta-analysis

Study	Number of Teeth	Follow-up Period (y)	Postoperative Pain/Total	Long-Term Outcome Failure/Total	Obturation Failure/Total	Overextension Cases/Total	Jadad Scale
Michanowicz et al. 1989 (1)	94	2	—	2/44*	—	—	4
			—	5/50†	—	—	
Lipski 2000 (28)	162	1–2	—	8/78*	—	7/78*	2
			—	5/84†	—	26/84†	
Li 2002 (34)	268	1–2	—	—	14/156*	14/156*	2
			—	—	4/112†	4/112†	
Wu 2004 (30)	60	0	—	—	12/30*	11/30*	2
			—	—	3/30†	3/30†	
Xiang 2004 (31)	189	0	—	—	13/94*	12/94*	1
			—	—	13/95†	6/95†	
Zheng 2004 (32)	218	1–2	—	4/80*	—	—	2
			—	14/138†	—	—	
Chu et al. 2005 (26)	71	3	—	7/37*	—	—	3
			—	7/34†	—	—	
Guo 2005 (29)	218	2	22/109*	14/109*	7/109*	7/109*	2
			20/109†	23/109†	9/109†	2/109†	
Qiao 2005 (33)	128	0	13/66*	—	6/66*	4/66*	2
			11/62†	—	14/62†	5/62†	
Aqrabawi 2006 (27)	340	5	—	33/180*	45/180*	24/180*	2
			—	34/160†	34/160†	13/160†	

*Teeth with warm gutta-percha obturation.

†Teeth with cold lateral condensation filling technique.

of clinical trials conform to the CONSORT (Consolidated Standards for Reporting of Trials) guidelines (18, 36, 37).

Research has shown that the peak incidence of chronic apical periodontitis occurs at 1 year after filling, and long-term assessments at 2, 3, and 4 years do not indicate an increased or accumulative risk of filled roots developing chronic apical periodontitis (38). Lipski (28) verified this result by reporting that the rate of healing was 94.2% with CLC and 90.2% with warm GP obturation 1 year after root canal therapy. After 2 years, the figures were 93.7% and 90.0%, respectively. Therefore, the follow-up periods chosen for long-term outcomes in this meta-analysis were 1 year at least.

A number of studies in vitro investigated the use of warm GP obturation leading to increased apical extrusion. Some studies verified a lower rate of overextension seen in the cases of applying CLC (11, 39, 40) whereas Frajlich (41) and Abarca (42) reported that there was no significant difference between the two treatments in the incidence of apical extrusion. Results using simulated models and extracted teeth were totally different from those in vivo. Without any doubt, the results of clinical trials and meta-analyses are more pertinent to clinical practice. Ten clinical studies were identified in this systematic review. The results showed overextension was more likely to occur in the warm GP obturation group in comparison with the CLC group. It was suggested that accurately defining the working length, avoiding destruction of the narrow part of the apical foramen during preparation, and using an appropriate insertion rate of warm GP can decrease the rate of overextension with warm GP (26, 28, 29).

The cases from six studies that were used to assess long-term outcomes between the two treatments included teeth with irreversible pulpitis and chronic apical periodontitis. Chu et al. (26) reported that root canal obturation outcomes were not significantly different ($p > 0.05$) between the groups containing teeth with and without preoperative apical periodontitis, respectively. Michanowicz et al. (1) showed that 24 months after treatment, the proportions of periapical lesions decreased from 44% to 15% in the CLC treated group, whereas in the warm GP obturation group the proportion of lesions decreased from 59% to 5%. Although a difference of 10% existed between the two groups concerning repair, it was not statistically significant. In this meta-analysis, the outcomes of teeth with irreversible pulp disease and chronic apical periodontitis were not separately analyzed for the following two reasons. First, the two included studies verified no significant difference between the two groups in long-term assessments. Second, the other four studies failed to provide the relative data. This situation is well worth analyzing separately, and it will be done when enough reports of clinical studies with proper classification in these data fields are received.

The warm GP obturation groups included several techniques, such as thermomechanical compaction, thermoplasticized injectable GP obturation, ultrasonic condensation of GP, and solid-core carry insertion technique. Generally, it is necessary to classify studies with different treatments and perform a further subgroup meta-analysis. However, it would be impossible to do this with the very small number of RCTs available. Heterogeneity between studies was assessed and showed that homogeneity existed among the studies with different techniques of warm GP obturation. Therefore, this meta-analysis is a preliminary analysis, and the subgroup meta-analysis will be the next step of study.

TABLE 2. Meta-analysis data summary

	RR, Warm GP versus CLC	95% CI		Overall Effect p-value
		Lower	Upper	
Postoperative pain	1.10	0.71	1.71	0.66
Long-term outcome	0.78	0.58	1.05	0.10
Obturation quality	1.31	0.98	1.76	0.07
Overextension	1.98	1.33	2.93	0.0007

Conclusion

The results of this meta-analysis demonstrated that a greater incidence of overextension was seen in the warm GP obturation group than in the CLC group. The obturation quality, long-term outcome, and postoperative pain prevalence were similar between these two groups. A subgroup meta-analysis will be performed in the near future in new studies.

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