Root Canal Treatment Using Thermoplasticized Carrier Condensation Technique

Air Cmde S Murali Mohan*, Wg Cdr SK Kaushik⁺

Abstract

Background: The management of pulpally and apically infected teeth has evolved into a modality of conservation with predictable degree of success. Root canal treatment often requires protracted chairside time. A new technique involving placement of thermoplasticized core carrier obturators was compared with conventional lateral condensation technique.

Methods: A prospective, comparative, in-vivo cohort study was carried out on randomly selected 100 patients visiting a tertiary care centre from July 2005 to July 2007, for primary, non-surgical conservative management of teeth requiring root canal treatment. Two groups of fifty cases each were managed with lateral condensation and thermoplasticized core carrier obturation techniques. Outcome variables were rate of obturation and failure rates as assessed by clinical and radiological evaluation.

Result: The time taken in case of lateral condensation of maxillary central incisor was 17.30 ± 3.373 minutes and 28.07 ± 2.586 minutes in case of mandibular molar. In the thermoplasticized carrier condensation technique, for the central incisors it took 13.00 ± 1.376 minutes and 21.07 ± 2.463 minutes for mandibular molars. The mean rank value for time taken for obturation as per Mann Whitney U test ($p < 0.01$) were 27.88 for maxillary incisor and 44.73 for mandibular molar in the lateral condensation technique and 13.13 and 16.27 respectively for thermoplasticized gutta percha carrier condensation. The values were statistically significant. With 16% and 14% cases having unsatisfactory filling as evaluated by post filling radiograph, Chi square test two tailed p value was 0.6836 and there was no statistically significant difference between the two groups. An absolute failure rate of 10% was seen in lateral condensation group and 6% in thermo-plasticized carrier condensation group. Fisher exact 2-tailed p value was 0.71 and the difference in failure rate was not statistically significant.

Conclusion: Root canal obturation by thermoplasticized core carrier condensation technique is an effective alternative to conventional lateral condensation technique in terms of quick and successful outcome.

MJAFI 2009; 65 : 336-341

Key Words : Root canal treatment; Lateral condensation; Thermoplasticized core carrier condensation technique

Introduction

Endodontic treatment plays an important role in providing patients with high quality comprehensive dental care. The objective of canal filling in root canal treatment (RCT) is to prevent any communication between the oral cavity and the peri-apical tissues. The ingress of oral or tissue fluids via such communication may maintain the viability of any residual bacteria that survive the treatment. At the conclusion of endodontic therapy, the root canal space, including the patent accessory canals and multiple foramina, must be completely and densely filled with a biologically inert material [1]. Most obturation methods make use of a solid core material cemented into the canal with a sealer. Gutta-percha and root canal sealer are currently the obturation materials of choice, but they can be used in a variety of ways to obturate root canals [2]. Success or prognosis of root canal treatment depends on many variables. Among these is the technical quality of the

root canal filling. The method of canal preparation and the length of the root canal fillings, relative to the radiographic apex significantly affect success of conventional root canal therapy. Furthermore, the integrity of the root canal filling in the apical few millimeters is believed to be one of the criteria necessary to ensure successful endodontic treatment [3]. The results of treatment are also directly dependent on the preoperative status of the pulp and peri-apical tissues [4]. Studies have shown that thermoplasticized gutta-percha can easily be moved into the canal irregularities, thus replicating the intricacies of the root canal system [5]. The improved flow characteristics of warm gutta-percha can also result in reduced apical control and extrusion of material beyond the apical limits of the root canal space [6]. Thermoplasticized gutta-percha is used in warm lateral condensation, warm vertical condensation, coated carrier systems, injection systems and thermo-mechanical compaction techniques [7].

*Commandant & Dental Adviser (Air), Air Force Institute of Dental Sciences, Bangalore. ⁺Classified Specialist (Oral & Maxillofacial Surgery), No 1 Air Force Dental Centre, New Delhi.

Material and Methods

A prospective, experimental, comparative, in-vivo cohort study was carried out on randomly selected 100 patients visiting Air Force Institute of Dental Sciences, Bangalore from July 2005 to July 2007, for primary, non-surgical conservative management of teeth requiring root canal treatment. The patients were evaluated for inclusion based on clinical and radiological findings. Teeth included for the study were maxillary central incisors and mandibular first molar. Clinically patients who had frank carious exposure with or without vital pulp were included. The other inclusion criteria were periodontally healthy teeth and the patients had no history of periodontitis. Maxillary central incisors which were non-vital as suggested by clinical signs of discoloration, non-reacting to electronic pulp tester or traumatic exposure of pulp were also included in the study. Pre-operative Intra-oral peri-apical (IOPA) radiographs were taken using a paralleling technique with a film holder and the radiographs were assessed in a dark room using a magnifier. The radiographs were evaluated for the peri-apical status of the tooth. Further patients in whom radiograph showed peri-apical pathosis and breach in continuity or absence of lamina dura were included in the study. Exclusion criteria included extreme curvature of the canals, dilacerations, combined endodontic-periodontic lesions, large peri-apical radiolucencies involving more than the terminal third of the root apex, mandibular first molars having more than three canals.

A total of hundred teeth were divided equally into Group I and Group II depending upon the obturation technique undertaken. Both the groups were further divided into sub group A consisting 20 patients requiring RCT in maxillary central incisor and sub group B consisting of 30 patients requiring RCT in mandibular first molar. Biomechanical and chemical preparation of both the groups was carried out in the standard conventional manner using similar techniques and materials.

The root canals were undertaken for obturation only when clinically asymptomatic both on objective and subjective response. To reduce the chance of inadequate extension of the root canal filling, the filling procedure was preceded by a check radiograph with master cone (s) for lateral condensation technique (LC) and with size verifiers for thermoplasticized core carrier obturation technique (TF) in situ. AH-26 Root canal sealer was placed into the canal with a lentulospiral in both groups.

Teeth of Group I were obturated by traditional cold lateral condensation of gutta-percha (Fig.1a, 1b). A gutta-percha master cone was selected that fit snugly at the working distance. If necessary, the apical portion was adjusted with a scalpel blade until tug back was achieved. The apical part of the master cone was coated in sealer and then laterally condensed with a finger spreader and accessory gutta-percha points. Excess gutta-percha was removed with a hot instrument just below the cemento-enamel junction and the

Fig 1a : Radiographs of molar root canal treatment (RCT) : lateral condensation technique

Fig 1b : Radiographs of incisor root canal treatment (RCT) : lateral condensation technique

Fig. 2a : Radiographs of molar root canal treatment (RCT) : thermoplasticized core carrier technique

Fig. 2b : Radiographs of incisor root canal treatment (RCT) : thermoplasticized core carrier technique

remainder was condensed vertically with a small amalgam plugger. Time taken for obturation was measured using stop watch from the point root canal was ready for obturation after biomechanical preparation till the lateral condensation was complete including master cone fit and confirmation.

The teeth of Group II were obturated by thermoplasticized carrier method (Figs. 2a, 2b). Size verifiers were used to determine the correct size of thermoplasticized gutta-percha obturator for the canal prepared. Time was measured from the point the canal was ready for obturation to the moment the coronal part of the obturator was finally snapped including placement of size verifiers and confirmation.

IOPA radiographs were taken for both the groups postoperatively, after three months and six months of treatment. The radiographs were viewed under magnifying lens to look for defects in length and density of obturation, as also the peri-apical bony architecture for increase or decrease of an already existing radiolucency or appearance of a new lesion where none existed. The criteria for assessment of post operative radiographs is given in Table 1. The treated teeth then received either an intra-coronal restoration (amalgam or resin composite) followed by full crown prostheses. The root filled tooth was regarded as 'clinically sound' if there was no clinical sign or symptom such as pain, tenderness to percussion, mobility and soft tissue pathology like abscess or sinus tract. A treatment failure was recorded if the tooth had been extracted, demonstrated any clinical symptoms associated with apical periodontitis, or peri-apical radiograph showed deterioration of an already existing lesion or occurrence of fresh lesion where none existed at the

Table 1

The criteria followed to record information from radiographs

Variable	Criteria	Definition
Length of root canal filling	Acceptable	Root filling ending ≤ 2 mm short of radiographic apex
	Over	Root filling ending beyond the radiographic apex
	Under	Root filling ending > 2 mm short of radiographic apex
Density of root canal filling	Poor	Not uniform density of root filling with clear presence of voids and canal space is visible
	Acceptable	Uniform density of root filling without voids and canal space is not visible.

evaluation. The treatment outcome was categorized as successful only when a treated tooth was both clinically sound and rated as normal in the radiographic examination. The results were subject to statistical analysis for comparison of the failure rate and efficacy of timing for both the techniques.

Results

A total of randomly selected hundred teeth requiring root canal therapy were included in the study. This included fifty each in which lateral condensation and thermoplasticized carrier condensation technique of obturation was undertaken as summarized in Table 2. In both the groups further twenty central incisors and thirty mandibular molars were involved. The mean with standard deviation of patient age in Group I

Table 2**Treatment summary**

	G-I (Lateral condensation)			G-II (Thermoplasticized gutta percha carrier condensation)		
	Sub Group A Maxillary incisor	Sub Group B Mandibular molar	Total	Sub Group A Maxillary incisor	Sub Group B Mandibular molar	Total
Total	20	30	50	20	30	50
Vital tooth with pulpitis	06	05	11	04	08	12
Acute peri-apical periodontitis	08	18	26	10	15	25
Non-vital asymptomatic	06	07	13	06	07	13
Time taken	17.30 ± 3.373 m	28.07 ± 2.586 m		13.00 ± 1.376 m	21.07 ± 2.463 m	
Radiograph quality	U - 1 O - 1 D - 1	U - 2 O - 2 D - 1	08	U - 2 O - 2 D - 0	U - 0 O - 2 D - 1	07
Total	03/20	05/30	16%	04/20	03/30	14%
Clinical failure	1	1	2	2	1	3
Radiologic failure	2	2	4	0	1	1
Total failures*	3	2	5 (10%)	2	1	3 (6%)

*One case each in sub groups B of both groups had clinical & radiological failures

Notes: U – Under extended, O – Over extended, D – Density unacceptable

and II were 35 ± 14 and 30 ± 15 respectively. All the cases were reviewed after three and six month interval. Eleven teeth were diagnosed as acute irreversible pulpitis with vital pulp contents, 26 with acute apical periodontitis and 13 non-vital but asymptomatic in Group I as against 12, 25 and 13 respectively from Group II. The time taken in case of lateral condensation of maxillary central incisor was 17.30 ± 3.373 minutes and 28.07 ± 2.586 minutes in case of mandibular molar. In the thermoplasticized carrier condensation technique, it took 13.00 ± 1.376 minutes for central incisors and 21.07 ± 2.463 minutes for mandibular molars (Table 3).

In terms of post operative radiograph to assess the quality of fill, eight (16%) cases were unacceptable in lateral condensation when compared to seven (14%) cases in thermoplasticized gutta-percha technique. Four teeth were under-filled, two were over-filled and in two the density was unacceptable in lateral condensation technique totaling to cases (16%) when compared to two, four and one respectively each for thermoplasticized technique accounting for seven cases (14%). Chi squared equals 0.166 with 1 degree of freedom, the two tailed P value equals 0.6836 and statistically not significant (Table 4). No differences were observed between groups as to homogeneity or adaptation of root canal filling.

Evaluation of results demonstrated no differences between both techniques. In Group I, there were 5 (10%) absolute failure including two clinical and four radiological. One of the failure cases was both clinically and radiologically unsuccessful. Whereas in Group II, there were three clinical failures (6%) including one of which was unsuccessful radiologically also.

Using the Fisher exact test with p value less than 0.05, the difference in the failure rate for the two techniques was 10% for lateral condensation and 6% for carrier coated thermoplasticized technique, while Fisher exact 2 tailed p value was 0.71 and considered statistically not significant. The mean rank value for time taken for obturation as per Mann Whitney test, with $p < 0.01$ were 27.88 for maxillary incisor (G-IA) and

Table 3**Time taken for obturation in minutes**

Group	Time taken for obturation (minutes)		p-value (Mann-Whitney U)
	Mean ± S D	Mean Rank	
I A (20)	17.30 ± 3.373	27.88	p < 0.01
II A (20)	13.00 ± 1.376	13.13	
I B (30)	28.07 ± 2.586	44.73	p < 0.01
II B (30)	21.07 ± 2.463	16.27	

Table 4**Quality of root canal filling**

Radiograph quality	Group I Lateral condensation	Group I Thermoplasticized gutta percha
Acceptable	42	43
Unacceptable	8	7

Chi Squared equals 0.166 with 1 degree of freedom. The two tailed p value equals 0.6836

44.73 for mandibular molar in the lateral condensation technique (G-IB) and 13.13 (G-IIA) and 16.27 (G-IIB) respectively for thermoplasticized carrier condensation, and was statistically significant (Table 3).

Discussion

The first recorded root canal filling was placed 2,200 years ago. However, a plethora of canal-filling materials have evolved and new obturation techniques have been introduced very recently. Many of these new techniques are variations of the vertical compaction of warm gutta-percha, apical third filling, injection-type fillings, thermomechanical compaction and thermoplasticized gutta-percha with plastic or titanium core carrier [8,9].

A successful outcome for RCT after careful case selection relies on adequate removal of microorganisms from the root canal system and prevention of recolonization by placement of a well adapted root canal

filling that obliterates the canal space with a hermitically sealed apex and a good coronal seal [3].

The teeth sample selected were maxillary central incisors and mandibular first molar due to the relatively standard configuration of root canal anatomy and frequency of involvement. The studies undertaken by various authors in literature vary from incisors, cuspids and combination of anterior and posterior teeth [6-9].

Deus et al [8] reported that the method of canal preparation and the length of the root canal fillings, relative to the radiographic apex significantly affects success of conventional root canal therapy. Recently, Clinton et al [10] found that a higher success rate (87%) was associated with root fillings 2 mm short of radiographic apex compared to those that were greater than 2 mm from the radiographic apex (77%). In the present study the combination of manual and motorized drilling by nickel titanium instruments by way of crown down technique was undertaken for biomechanical preparation. In our study the quality of obturation based on the apical relation of filling was 84% and 86% in respect of lateral condensation and thermoplasticized carrier condensation techniques. The success rates were comparable and statistically not significant.

Lateral condensation (LC) has advantages of low cost and the ability to control the length of the fill. However, if there is poor canal preparation, inadequate pressure being applied, or a mismatch of tapers of spreader, GP cone and canal, there will be spaces between the GP cones, which are probably filled with sealer. On the contrary, overzealous application of pressure can result in vertical root fractures [2]. The prototype of thermoplasticized gutta-percha (TF) obturators was first described by Johnson in 1978 [11]. The latest product consists of a plastic or titanium core, or carrier, coated with a-phase GP [12]. Many laboratory studies have been performed on various attributes of TF filling including apical or coronal leakage, the quality of filling or material adaptation [9,11,12]. Most reports concluded that TF is an acceptable alternative to the LC technique. However, clinical trials are scarce. The commonly undertaken studies in literature showed mostly in-vitro studies with extracted human teeth in a laboratory setting based on SEM examination after dye immersion for prescribed periods of time and radiographic examination of the filled tooth in various dimensions. Studies have also revealed that apical seal may be crucial in outcome of root canal therapy but success has also resulted in over extended overfilled and under extended, underfilled teeth.

A study comparing the core-to-sealer ratios of different GP filling techniques reported that TF was better than LC because TF produced higher GP content.

However, the canal length of fill is difficult to control and is affected by the rate of insertion. A fast insertion rate may produce overextension of the GP whereas a slow insertion rate may result in underfill. Lateral condensation had the lowest core/sealer ratio and thermoplasticized gutta-percha with carrier was found to be superior to the lateral condensation technique in terms of core/sealer ratio and dye [12].

Dye penetration studies are useful way of comparing new obturation techniques with a known standard. However, their clinical relevance is limited because root fillings may allow the passage of dye and still be successful [13].

Chu et al [14] compared the adaptation and placement of alpha-phase gutta-percha delivered with a plastic core-carrier, thermoplasticized gutta-percha with lateral condensation of gutta-percha and found thermoplasticized gutta-percha provided better overall canal obturation. Lipski et al [15], found the use of thermoplasticized gutta-percha obturators to be less tedious and time-consuming as compared to laterally condensed gutta-percha.

Filling root canals with TF is more rapid than LC as reported by many authors in laboratory studies [16,17]. These data do not represent the actual clinical setting. Moreover, many laboratory studies were performed on extracted single-rooted teeth, the canals of which were usually wide and straight and did not pose any treatment difficulty, while our study involved both single and multi rooted teeth in a clinical setting.

Success of root canal treatment has been shown in the range between 53% and 94% [18, 19]. In the present study, no difference in the clinical and radiographic status was observed in teeth filled using TF as compared to LC after 12 months of observation. However, the time taken by thermoplasticized gutta percha technique was significant by lesser than the conventional lateral condensation technique. This suggests that TF is an acceptable alternative to the conventional cold LC technique.

Conflicts of Interest

This study has been financed by research grants from the O/o DGAFMS, New Delhi.

Intellectual Contribution of Authors

Study Concept : Air Cmde S Murali Mohan

Drafting & Manuscript Revision : Air Cmde S Murali Mohan, Wg Cdr SK Kaushik

Statistical Analysis : Wg Cdr SK Kaushik

Study Supervision : Air Cmde S Murali Mohan

References

- Schilder H. Filling of the root canal in three dimensions. J Endod 2006; 32:281-90.

2. Carrotte P. Endodontics: Part 1. The modern concept of root canal treatment. *Br Dent J* 2004; 197:181-3.
3. Seltzer S, Soltanoff W, Sinai I, et al. Biologic aspects of endodontics part III. Peri-apical tissue reactions to root canal instrumentation. *J Endod* 2004; 30:491-9.
4. Bender IB, Seltzer S, Yermish M. The incidence of bacteremia in endodontic manipulation. *J Endod* 2003; 29:697-700.
5. Gutmann JL. How far have we come in endodontic treatment? *J Hist Dent* 2000; 48:90.
6. Gencoglu N, Yildirim T, Garip Y, et al. Effectiveness of different gutta-percha techniques when filling experimental internal resorptive cavities. *Int Endod J* 2008; 41:836-42.
7. Gencoglu N, Garip Y, Bas M, Samani S. Comparison of different gutta percha root filling techniques: Thermoplasticized gutta-percha, Quick-fill, System B and lateral condensation. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2002; 93:333-6.
8. De-Deus G, Gurgel-Filho ED, Magalhães KM, et al. A laboratory analysis of gutta-percha-filled area obtained using thermoplasticized guttapercha, System B and lateral condensation. *Int Endod J* 2006; 39:378-83.
9. Abarca AM, Bustos A, Navia M. A comparison of apical sealing and extrusion between thermoplasticized guttapercha and lateral condensation techniques. *J Endod* 2001; 27:670-2.
10. Clinton K, Van Himel T. Comparison of a warm gutta-percha obturation technique and lateral condensation. *J Endod* 2001; 27:692-5.
11. Da Silva D, Endal U, Reynaud A, et al. A comparative study of lateral condensation, heat-softened gutta-percha, and a modified master cone heat-softened backfilling technique. *Int Endod J* 2002; 35:1005-11.
12. Gondola N. Comparison of 6 different gutta-percha techniques (part II): Thermoplasticized gutta-percha, JS Quick-Fill, Soft Core, Micro seal, System B, and lateral condensation. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2003; 96:91-5.
13. Guigand M, Glez D, Sibayan E. Comparative study of two canal obturation techniques by image analysis and EDS microanalysis. *Br Dent J* 2005; 11; 198:707-11.
14. Chu CH, Lo EC, Cheung GS. Outcome of root canal treatment using Thermoplasticized guttapercha and cold lateral condensation filling techniques. *Int Endod J* 2005; 38:179-85.
15. Lipski M. Studies comparing the efficacy of root canal filling with gutta-percha lateral condensation and Thermoplasticized guttapercha obturators. *Ann Acad Med Stetin* 2000;46:317-30.
16. Levitan ME, Himel VT, Luckey JB. The effect of insertion rates on fill length and adaptation of a thermoplasticized gutta-percha technique. *J Endod*. 2003;29:505-8.
17. Goldberg F, Artaza LP, De Silvio A. Effectiveness of different obturation techniques in the filling of simulated lateral canals. *J Endod* 2001; 27:362-4.
18. Yücel AC, Ciftçi A. Effects of different root canal obturation techniques on bacterial penetration. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2006 ;102:88-92.
19. Peak JD, Hayes SJ, Bryant ST. The outcome of root canal treatment. A retrospective study within the armed forces (Royal Air Force). *British Dental Journal* 2001; 190: 140-4.

Journal Scan

Michael Perry. Acute Proptosis in Trauma: Retrobulbar Hemorrhage or Orbital Compartment Syndrome—Does It Really Matter? *J Oral Maxillofac Surg* 2008;66:1913-20.

This article reviews the nature and outcomes of acute severe proptosis in patients after craniofacial trauma, over a six-year period. In each patient the mechanism of injury, nature of the proptosis and visual outcomes were reviewed. The author found that in all cases proptosis, was secondary to retrobulbar edema and not haemorrhage. Many cases of “retrobulbar haemorrhage” (RBH) may, in fact, be secondary to edema. This has significant implications when managing the proptosed eye on an emergent basis. Possible reasons for poor outcomes are discussed in the article. A number of unanswered questions arise from this review such as when is a proptosis severe enough to warrant urgent decompression on clinical grounds alone? When is swelling maximal and therefore the globe

most at risk? How decompression is best achieved, if the underlying cause (bone, blood, edema, air, or frontal lobe) is not known? If decompression is not undertaken, can any resulting chronic ischemia result in muscle fibrosis and contractures, much akin to the Volkmann’s ischemic phenomenon?—“Orbital Volkmann’s”. Does the patient’s systemic blood pressure affect orbital perfusion and the decision to decompress (or not)? This article is a complete review on the management of proptosed eye irrespective of oedema or haemorrhage.

Contributed by

Maj R Sharma*, Col R Sinha†, Col PS Menon‡

*Graded Specialist (Oral & Maxillofacial Surgery), MDC, Jalandhar Cantt. †Prof & Head (Dept of Dental Surgery), AFMC, Pune.

‡Director (E&S) O/o DGDS, Ministry of Defence, New Delhi.