Cold hydraulic condensation (sealer-based) root canal obturation: what are the differences in clinical techniques from the traditional obturation?

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Abstract

Recently, a calcium silicate-based root canal (CSRC) sealer has been introduced. CSRC sealer is designed for a special obturation technique by using it as a main obturation material in root canals, namely cold hydraulic condensation (CHC) or sealer-based root canal obturation. The obturation techniques of CHC using CSRC sealer are different from that of traditional obturation. In particular, more conservative root canal preparation, single matched main cone, final rinse with normal saline solution or distilled water, moist canals before obturation, creating gutta-percha plug at the orifice, cleaning the sealer using sponge or micro-brush followed by irrigation, and delaying post-space preparation are described.

Keywords: Cold hydraulic condensation, Endodontic treatment, Root canal obturation, Sealer-based technique

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Received: 14 October 2025 **Revised:** 22 November 2025 **Accepted:** 25 November 2025

What is the cold hydraulic condensation obturation?

A common root canal obturation technique that has been used for many decades is either lateral compaction or warm vertical compaction. This traditional technique uses gutta-percha as a main obturation material to fill the prepared root canals. A root canal sealer is used as minimally as possible to additional seal minor spaces or irregularities. This obturation technique shows the successful clinical outcome [1].

A calcium silicate-based root canal (CSRC) sealer has been firstly introduced in 2008, namely EndoSequence BC Sealer (Brasseler, Savannah, GA, USA), which is a pre-mixed, injectable product. Later, CSRC or strontium-silicate based sealers in pre-mixed or two-component form have been available **(Figure 1)**. This novel sealer possesses advantages such as no shrinking after setting, flowability, hydrophilicity, antibacterial property, and biocompatibility [2]. The sealer is usually produced in an injectable, ready-to-use material in a syringe form. CSRC sealer is set by hydration reaction from the remaining moisture inside the root canals. In addition, other silicate-based sealer is also introduced in the market, such as a strontium silicate-based sealer, but a few of its scientific evidence has been reported [3].

CSRC sealer is designed for a special obturation technique by using it as a main obturation material in root canals, namely cold hydraulic condensation (CHC) or sealer-based root canal obturation [4]. In the CHC obturation technique, a gutta-percha cone is only used as a plunger to distribute the sealer as well as keep a pathway for retreatment. The sealer is injected from a syringe or loaded by using a lentulospiral into the root canals before a main gutta-percha cone is placed to spread the sealer. Later, the gutta-percha cone is cut by heat and packed at the orifices using an endodontic

Figure 1 Examples of calcium or strontium silicate-based sealers in pre-mixed or two-component form (each image obtained from manufacturer's website).

plugger. The obturation techniques of CHC using CSRC sealer are different from that of traditional obturation. Therefore, this article aims to describe differences in clinical techniques of CHC obturation using CSRC sealer compared to those of traditional obturation.

What are the differences in clinical techniques of CHC obturation from traditional obturation?

The differences in clinical techniques between CHC obturation and traditional obturation are summarized in **Table 1**.

Table 1 Differences in clinical techniques between CHC obturation and traditional obturation (abbreviations: NaOCl- sodium hypochlorite; EDTA- ethylene diaminetetraacetic acid; NSS- normal saline solution; and CSRC- calcium-silicate root canal sealer)

Clinical steps	Traditional obturation (lateral or warm vertical compaction)	Cold hydraulic condensation (sealer-based)
1. Root canal preparation	May require further preparation to create enough spaces for insertion of specific instruments (e.g. spreader or heat carrier) in obturation.	More conservative due to no need of specific instruments in obturation.
2. Try main cone	Main cone with .02-.06 taper or matched-taper can be used depending on the obturation techniques, which the cone is 'tug-back' fit.	Matched-taper single cone with very 'tug-back' fit to prevent displacement of the cone and enhance spreading of the sealer.
3. Final root canal irrigation	NaOCl → EDTA → NaOCl. Dry canals.	NaOCl → EDTA → NaOCl followed by NSS or distilled water. Moist canals to promote hydration reaction of the sealer.
4. Obturation procedure	Gutta-percha is used as a main obturation material while traditional sealer is coated on canal walls and gutta-percha cones as thin as possible.	CSRC sealer is injected or loaded into the canal as much as possible, being a main obturation material.
5. Cleansing the sealer on coronal access	Using alcohol-soaked cotton pellets.	Initially removed by dry sponge/ micro-brush followed by moist sponge/micro-brush, and a final gentle rinsing with NSS or distilled water.
6. Post-space preparation	Immediate or delay post-space preparation is possible.	Delay post-space preparation is preferred due to the majority of CSRC sealer is sensitive to heat.

Root canal preparation

Following the biomechanic principle, root canal preparation for CHC obturation can be more conservative than that for the traditional obturation [5]. CHC obturation does not require any specific instruments in the procedure. In contrast, the traditional obturation may require further canal enlargement in some clinical situations to create enough spaces for insertion of root canal spreaders in the lateral compaction or heat carriers/ root canal pluggers in the warm vertical compaction **(Figure 2)**. The more root structure remains, the higher the strength of the root is preserved.

Main cone

A main gutta-percha cone used for CHC obturation must be well-fitting. For CHC obturation, a single main cone is usually used that requires a 'tug-back' to ensure fitting to apical segments of prepared root canal, as well as preventing any displacement during obturation, particularly in the step of heat cutting at the orifices [6]. Otherwise, a hybrid technique by additional placement of lateral or accessory gutta-percha cones (either with or without using a root canal spreader) may be used to enhance sealer distribution, especially in a large or oval canal where well-fitting of the main cone is not achieved. Moreover, in long-oval canals, two main cones can be used, which the secondary cone is placed as close as the working length of the primary cone. In addition, a matched taper main cone is preferred in CHC obturation. The tapering of the main cone matched or close to the prepared canals improves the spread and adaptation of root canal sealer to root canal walls [7].

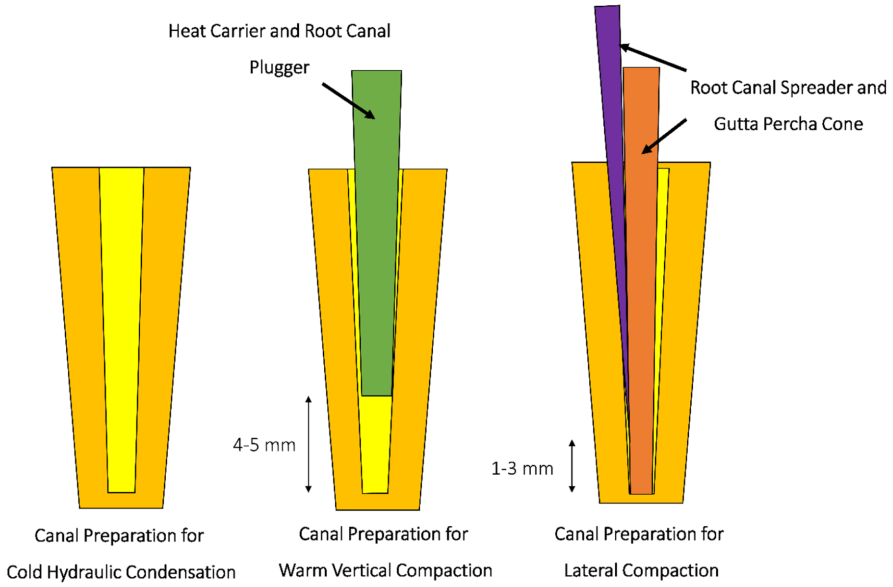

Figure 2 Root canal preparation for cold hydraulic condensation obturation does not require any specific instruments in the procedure; therefore, further canal enlargement is not necessary. In contrast, the traditional obturation may require further canal enlargement to create enough spaces for insertion of root canal spreaders in the lateral compaction or heat carriers/ root canal pluggers in the warm vertical compaction.

Final root canal irrigation

CHC obturation needs final root canal irrigation, different from the traditional methods. CSRC sealer is an injectable, ready-to-use preparation that requires intracanal moisture for initiating the setting reaction [4]. Therefore, after drying root canals for checking any remaining exudate at apical regions, the root canals should be remoistened (but not over-wet). A paper point moistened with a proper solution, such as normal saline solution (NSS), should be used to re-wet the canal **(Figure 3)**. Dry or over-wet canals lead to delay in sealer setting and decrease in adhesion to root dentine of the sealer [8].

An irrigant that should be used as the final irrigation is NSS or distilled water [6]. For the traditional obturation, sodium hypochlorite (NaOCl) is commonly used after ethylenediamine tetra-acetic acid (EDTA) irrigation. NaOCl or EDTA may interfere setting reaction of CSRC sealer, so this solution should be finally flushed out of the canal by irrigation with NSS or distilled water before CHC obturation [9, 10] **(Figure 3)**. In cases that chlorhexidine (CHX) solution is used as a final rinse, its effect on CSRC sealer is controversial [6, 10].

Obturation procedure

This procedure is the main difference between CHC obturation and traditional obturation. For CHC obturation, the sealer (i.e., CSRC) is injected or loaded into the canal as much as possible, being a main obturation material [6]. For a pre-mixed CSRC, the intracanal tip is inserted to middle or apical root level (but at least 1-2 mm short from working length to prevent sealer extrusion) before slowly injection and simultaneously withdrawal of the tip. For a two-component CSRC, the mixed sealer is loaded into a 1-ml syringe for injection or filled into the canal using a lentulospiral by insertion 1-2 mm short from working length. After that, a matched-taper, gutta-percha cone is inserted into the canal until the working length to create hydraulic force that spreads the sealer into the apical part and canal walls **(Figure 4)**. In cases where loading or pushing the sealer into the apical area is not well achieved, using a supplemental device such as a lentulospiral in loading the sealer may be helpful [11]. Moreover, CSRC sealer in a mixing powder-liquid preparation, e.g., BioRoot RCS (Septodont, Saint-Maur-des-Fossés, France), can be loaded into the canal after mixing by

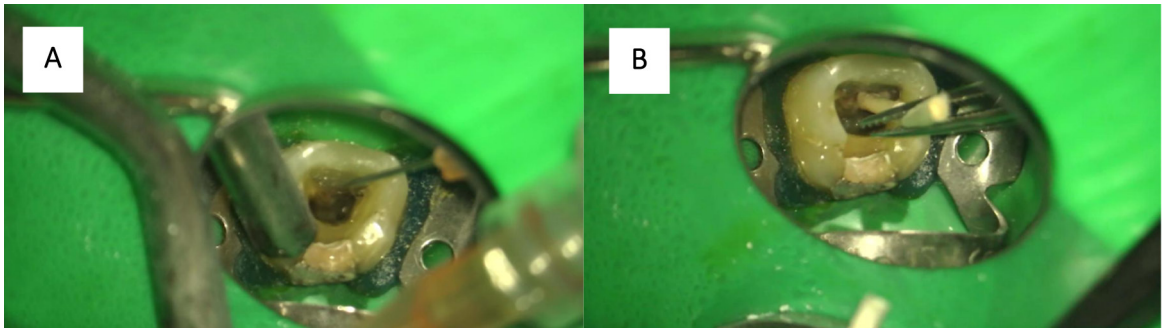

Figure 3 (A) For CHC obturation, root canals are irrigated with normal saline solution after irrigation with NaOCl and EDTA. (B) After canal-drying, the canals are remoisten using normal saline-moist paper points, being a source of moisture for the hydration reaction of the sealer. For CSRC sealer, over-dry or over-wet the canals should be avoided. (CHC: cold hydraulic condensation; CSRC: calcium silicate-based root canal sealer)

using a lentulospiral or 1-ml syringe with a proper-size needle tip.

CSRC sealer is set after several hours; therefore, the obturated canals need a 'gutta-percha' as a cork or coronal plug to prevent dissolution of CSRC sealer during adhesive procedure (particularly etching and rinsing) of coronal restorations [12]. After insertion of gutta-percha cone, the cone should be cut by heat 2-4 mm above the orifice (not at the orifice level) and then plugged using an endodontic plugger **(Figure 5)**. This technique creates the gutta 'cork' or plug at the entrance of canal with very thin layer of sealer, which markedly reduces the dissolution of CSRC during sealer cleaning or when in contact with etching or bonding. Moreover, using 'secondary' main gutta-percha or accessory, lateral cones may be helpful in long-oval canals (especially very

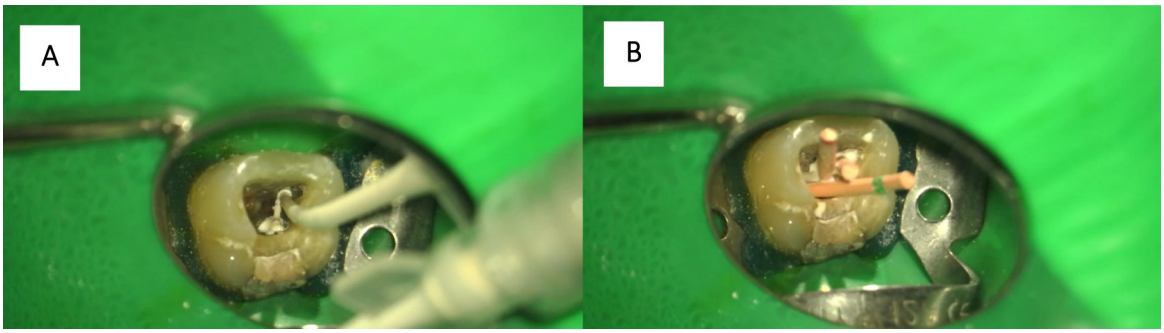

Figure 4 (A) For CHC obturation in the root canals, the injectable, ready-to-use CSRC sealer is filled into the moist canals by inserting the tip to middle or apical root level (but at least 1-2 mm short from working length and without binding of the tip to canal walls to prevent sealer extrusion). The sealer is slowly injected into the canal and, simultaneously, withdrawal of the tip. (B) After sealer loading, the main gutta-percha cones are put into the root canals to spread the sealer into the apical portion. In addition, these main cones keep pathways for retreatment if required. This 'trial pack' of gutta-percha cones in root canals can be checked radiographically before heat cutting. (CHC: cold hydraulic condensation; CSRC: calcium silicate-based root canal sealer)

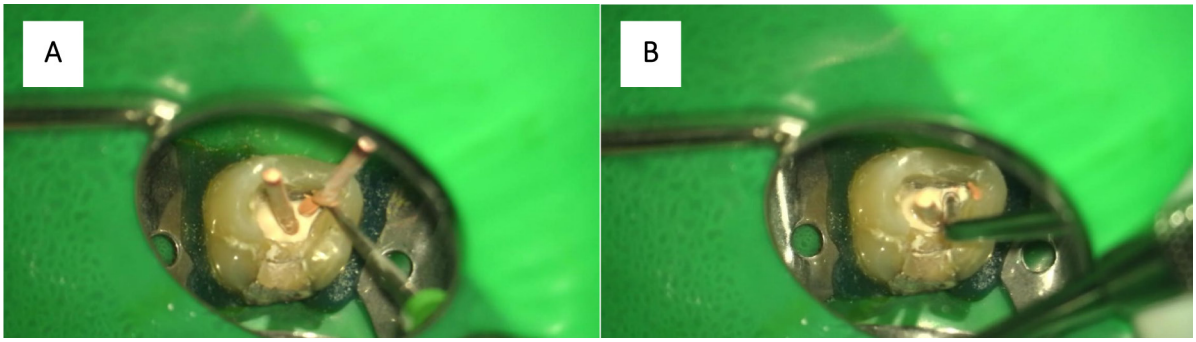

Figure 5 (A) For creation of the gutta 'cork' or plug at the orifices to protect the sealer from dissolution, the gutta-percha main cone should be cut 2-4 mm above the orifice (not at the orifice level). (B) The heated gutta-percha cone is plugged into the orifice using an endodontic plugger.

oval at the coronal third) to create the gutta-percha plug. However, using the hybrid technique by adding lateral cones in such oval canals is controversial, as placing a root canal spreader may increase voids inside the sealer [13].

In CHC obturation, a trial pack of canal obturation at the apical area can be checked radiographically before cutting the gutta-percha cones. If any major voids or defects are detected at the apical region, the main cone can be easily removed. Next, more sealer is added by injection or loading with a lentulospiral, and then the main cone is re-inserted into the canal before another radiographic examination.

Cleaning the sealer

In CHC obturation, CSRC sealer is used in a large amount, and which remnants of sealer on the walls of cavity access should be completely cleaned before the adhesive procedure of coronal restorations. Even though CSRC sealer is a water-based material that can be easily removed from coronal dentine, the sealer must be carefully cleaned due to the concern of dissolution of unset sealer around the orifices. In addition, using alcohol-soaked cotton balls to remove a large amount of the sealer may not be effective [14]. Moreover, rigorous washing or rinsing with an air-water spray may not be appropriate. Instead, the sealer remnants should be initially removed by a dry sponge or using a micro-brush [15] followed by a moist sponge/micro-brush, and a final gentle rinsing with NSS or distilled water **(Figure 6)**.

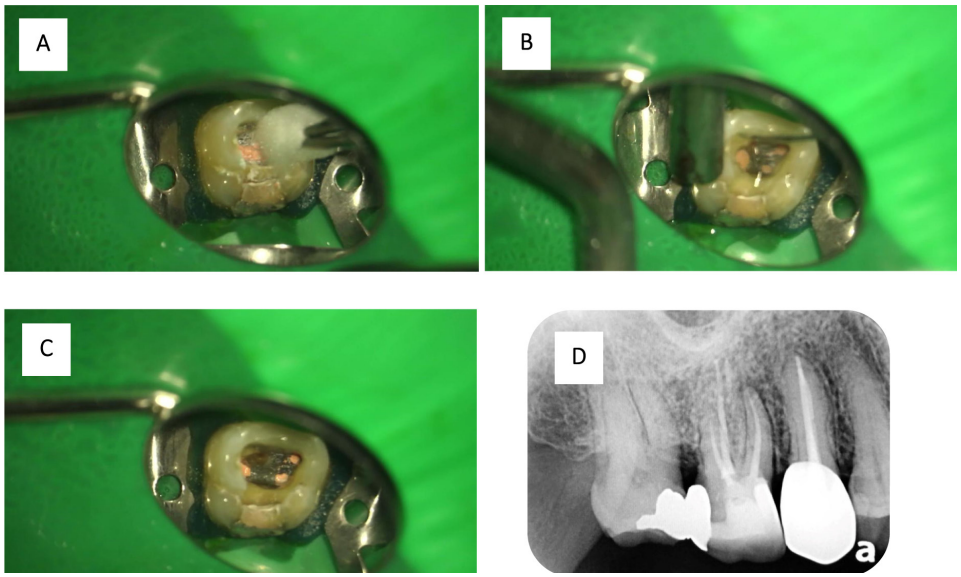

Figure 6 (A) After root canal obturation, the sealer remnants in the pulp chamber should be initially cleaned by a dry sponge or micro-brush, followed by a moist sponge. (B) The pulp chamber is finally and gently rinsed with NSS or distilled water to wash out the sealer remnants. (C) The access cavity is completely cleaned before adhesive restoration. (D) A final radiograph shows the root canals of the first maxillary right molar obturated with CHC obturation using CSRC sealer. (CHC: cold hydraulic condensation; CSRC: calcium silicate-based root canal sealer)

Delay post-space preparation may be preferred after CHC obturation. The majority of CSRC sealers are designed not to be used with the warm vertical technique, as the properties of the sealer are negatively affected by the heat such as accelerating setting time, decreasing flowability, and increasing film thickness [16]. Thus, the sealer should be allowed to set inside the obturated canals for at least 24-72 hours before post-space preparation. As previously mentioned, canal dryness extends the setting time of CSRC sealer, so the post-space preparation period in such cases should be delayed more than usual. A CSRC sealer modified for the warm vertical technique (such as EndoSequence BC Sealer HiFlow, Brasseler USA, Savannah, GA, USA), less affected by the heat, may be used if the immediate post-space preparation is planned [16]. However, it has been recently reported that delay or immediate post-space preparation after obturation with conventional CSRC sealer does not affect the bond strength of fiber post to root canal dentine [17]. In addition, after post-space preparation, remnants of CSRC sealer on root canal walls can be left without a decrease in bond strength of prefabricated fiber posts [17].

Conclusion

Clinical techniques in CHC obturation using CSRC sealer are partly different from the traditional obturation methods **(Table 1)**. In particular, more conservative root canal preparation, single matched main cone, final rinse with NSS (or distilled water), moist canals before obturation, creating gutta-percha plug at the orifice, cleaning the sealer using dry and moist sponge (or micro-brush), and delaying post-space preparation are mentioned **(Figure 7)**.

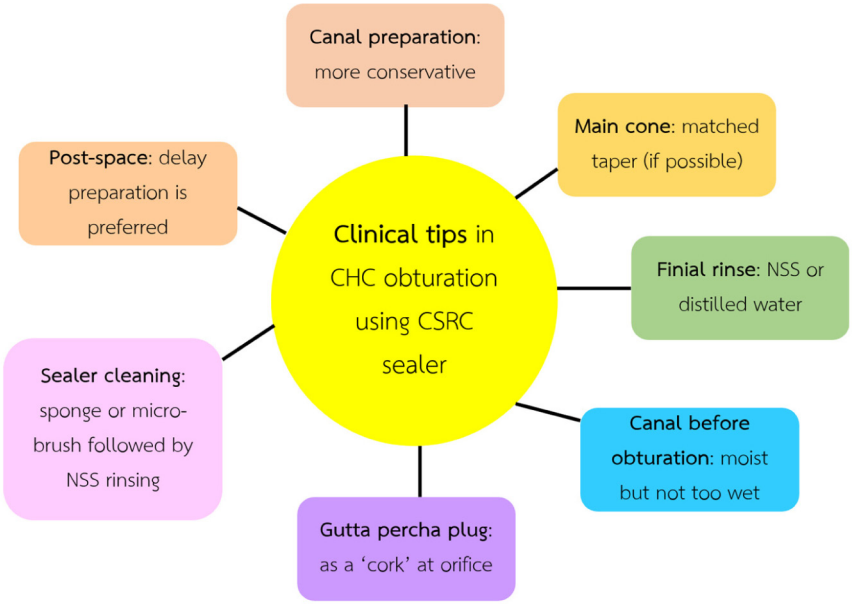

Figure 7 Summary of clinical tips in CHC obturation using CSRC sealer. (CHC: cold hydraulic condensation; CSRC: calcium silicate-based root canal sealer)

Ethic approval

N/A

Acknowledgement

None

Funding source

None

Conflict of interest

None

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