

# Resorcinol-Formaldehyde Resin “Russian Red” Endodontic Therapy

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**Resorcinol-formaldehyde resin is a material used in endodontic therapy in many foreign countries. With immigration to the United States increasing, American dentists need to become familiar with resorcinol-formaldehyde therapy. It contains two potentially toxic components, formaldehyde (liquid) and resorcinol (powder). Zinc oxide or barium sulfate may be used for radiopacity. When 10% sodium hydroxide is added to the mixture, polymerization occurs, which can form a brick-hard red material that has no known solvent. Several variations in technique exist. The catalyst can be mixed in before insertion into the tooth, added after the mixture is inserted, or not used. Providers believe pulp tissue will be fixed and bacteria destroyed apical to the level of resorcinol-formaldehyde resin placement. Canals are frequently not instrumented or obturated to their full length. Few success-failure studies have been published and results are contradictory. Consequently, providers have little guidance regarding when to retreat or for predicting the difficulty of retreatment.**

Resorcinol-formaldehyde (RF) resin therapy, commonly known as “Russian Red” cement, has been a unique method of endodontic therapy in Eastern Europe, Russia, China, and other countries around the world. RF resin is a combination of formaldehyde/alcohol, resorcinol powder, and a sodium hydroxide catalyst. It is mixed to various consistencies and placed in root canals as a temporary or permanent obturating material. The methods for using RF therapy were described in 1957 and have been widely used since 1960 (1).

With the combination of increased mobilization of the world population and immigration to other countries, American dentists are now seeing more patients treated with this therapy (2). The material and technique differ from the familiar gutta-percha techniques and providers may find information on the subject useful when evaluating patients with Russian Red endodontic therapy.

This purpose of this article is to review literature describing the materials and techniques used with RF endodontic therapy and to

discuss clinical considerations when evaluating and retreating RF cases.

## Components of Resorcinol-Formaldehyde Resin

Formaldehyde pastes have been used for endodontic therapy for over a century. In 1898, Gysi introduced a formaldehyde paste known as Gysi’s Triopaste for endodontic therapy (3). Its purpose in paste formulations is to cause histopathologic fixation of the remaining pulp tissue. Fixation refers to the process of cross-linking proteins that purportedly inhibits autolysis of the pulp tissue. Formaldehyde is also an effective antimicrobial agent against bacteria, fungi, and virus. However, its efficacy is dependent on conditions within the pulp chamber and canal and may be limited because of its tendency to bind to organic matter.

Formaldehyde is highly toxic and can cause significant inflammation to connective tissue (4). In endodontics, formaldehyde can diffuse out the apical opening and lateral canals and can injure the periodontal ligament and surrounding tissues (3). This becomes more problematic when additional formaldehyde is used to thin the RF paste mixture to allow it to permeate the canal space.

Resorcinol is a white crystalline powder that has many uses in medicine. It is combined with formaldehyde and gelatin to form a glue that allows growth of collagen and elastic fibers (5). Gelatin resorcinol-formaldehyde glues are used to treat dissecting aneurysms (6), close skin wounds (7), and seal pulmonary air leakage during lung surgery (8). In dentistry, resorcinol resins that help arrest dental caries have been developed (9).

Unfortunately, resorcinol resins and glues have also been shown to have toxic side effects. Workers who were introduced to a resorcinol resin used in the tire manufacturing process developed pulmonary infiltrates, focal interstitial fibrosis, and peribronchial and perivascular inflammation (10). Dermatologic allergic reactions can occur with the use of resorcinol-based, skin-peeling agents (11). When RF resin is used as an adjunct for controlling postextraction hemorrhage, special care is used to ensure that the RF resin does not contact the bone because it can cause bony sequestration (12).

Another disadvantage of RF resin is that the resorcinol discolors tooth structure (2). Color changes range from a pink to a deep burgundy, darker colors occurring when more resorcinol is incorporated into the paste.

RF resin is not radiopaque, but radiopacifiers are often added. The early traditional preparations were made radiopaque by the

addition of zinc-oxide powder. Current commercial RF preparations now include barium sulfate in the formaldehyde liquid component (13).

### Clinical Use of Resorcinol-Formaldehyde Resin in Endodontics

#### GUIDELINES

RF resin is promoted as an efficient and cost-effective method of root canal therapy. The resin purportedly permeates infected root canals and destroys bacteria, "resinifies" residual pulp tissue rendering it harmless, obturates the canal, and prevents reinfection. Advantages of this technique include eliminating the need for complete pulp tissue removal and antibacterial additives (1). Indications advocated for RF endodontic therapy include chronic apical periodontitis, carious exposures of vital teeth requiring partial pulpectomy, and teeth with broken instruments or foreign material in the canal (if space is present for the resin to bypass the obstruction). Contraindications include treating anterior teeth because of the staining that occurs with RF fillings and immature teeth because of the potential interference with root development (14).

#### PROCEDURES

The procedure used for RF resin fillings varies with the clinical situation. When a pulp exposure occurs and the dentist determines that the pulp should be removed, an arsenic paste can be placed on the exposed pulp and sealed for 1 to 2 days (2). When the patient returns, the RF endodontic therapy is initiated. Mechanical and chemical agents are used to remove as much pulp tissue as possible. Providers may not be able to mechanically negotiate canals beyond severe curvatures or obstructions. The canals are rinsed with antiseptic solutions and chelating agents, such as EDTA or boric acid, which are used to open the canal spaces. A 0.1% lysozyme solution is sometimes used as an irrigant to break down pulpal tissues. The canals are dried with ether, and antibiotics are occasionally placed into the pulp chamber to control infection.

Next, the RF resin is mixed. To prepare the early traditional RF mixture, 2 to 3 drops of 40% formalin are placed on a glass slab and crystalline powder of resorcinol is added incrementally. The resorcinol will dissolve in the formalin until the formalin is saturated with resorcinol crystals. Then, 1 to 2 drops of the catalyst, a 10% NaOH solution, is added to the mixture to start the polymerization reaction. This liquid mixture is placed into the root canal where polymerization continues and the material becomes a solid. Today, resorcinol formaldehyde kits containing formaldehyde, resorcinol powder in water, and an aqueous NaOH solution are commercially available (13).

The RF resin is placed in pulp chamber and worked into the canals with an instrument, file, spreader, paper points, or any other method of facilitating obturation of the entire canal. In larger diameter canals, silver points can be inserted or instruments fractured to obturate the canal. A filler, such as zinc-oxide powder, can be added to the mixture to increase viscosity and to help with obturation as shown in Figs. 1 to 3 (4, 14).

When canals cannot be negotiated because of curvature or obstruction as demonstrated in Fig. 3, the procedure is modified. A camphor-phenolic medication or 40% formalin is first placed into the canal at the initial appointment. At a second appointment, a



FIG 1. Tooth #19 instrumented and obturated with radiolucent RF resin with radiopaque powder in orifice openings.



FIG 2. Tooth #12 obturated with radiolucent RF resin with a lentulo spiral instrument intentionally or unintentionally remaining in one canal.

resorcinol-formaldehyde resin mixture, lacking NaOH, is placed as far into the canals as possible. The noncatalyzed RF resin transforms from a liquid to a gel stage with a sap-like consistency. A RF resin-soaked piece of asbestos or similar material is also sealed into the pulp chamber to replenish the resin on the floor of the chamber and then the tooth is temporized (15). At the next appointment, RF resin using the NaOH catalyst is placed into the canals and the tooth is restored.

Variations of this procedure occur and procedures can be combined resulting in fewer appointments. One modification is to place the RF mixture in the canals and followed by a drop of catalyst in the canal or chamber to start the polymerization process. The purpose is to drive the RF mixture as far apically and laterally as possible, obturating dentinal tubules and lateral canals and then adding the catalyst to polymerize the canal system (15).

Another modification is used for primary teeth with pulpal involvement (13). After coronal pulpotomy, a cotton pellet soaked in RF resin is placed on the pulp stump. The pellet is removed and replaced with RF resin mixed with zinc-oxide powder and the tooth is restored. In a study, septic primary teeth that were treated with RF therapy were found to be aseptic 84% of the time after treatment (16).

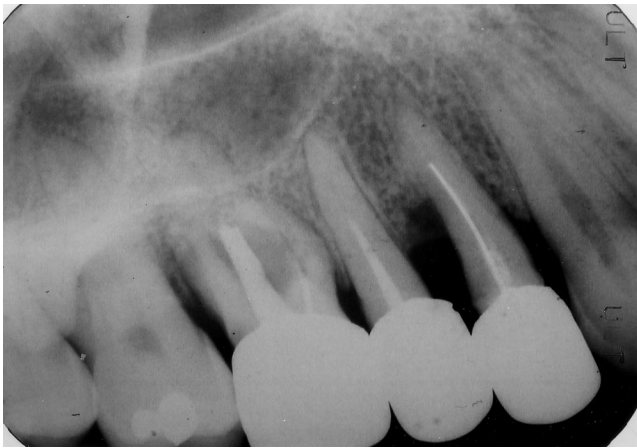


FIG 3. Teeth #3, #4, #5 obturated with RF resin exhibiting periapical and periodontal disease. Tooth #3 and #4 exhibit radiopaque powder partial obturation; #5 shows a silver point cemented with RF resin.

### DISCUSSION

Sikri et al. (4, 14) in 1995 measured the success of treatment by the reduction in the “mean radiolucency” of the lesion. They determined after 9 months that the success rate for RF endodontic therapy was 84.1%. The mean decrease in radiolucency size was 2.1 mm after 3 months, 4.0 mm after 6 months, and 5.8 mm after 9 months. Wu and Wang (1) reported success rates of 82% at 12 months and 97.6% after 3 to 4 yr. However, Kaminska-Litwin and Waszkiel (17) showed that complications develop in 95.4% of cases treated with resorcinol-formalin paste.

Many dentists are unfamiliar with RF resin endodontic therapy. This technique reports successes, but failures do occur. Retreatment on resin-treated teeth can be an unpredictable experience. On entering the chamber, one can encounter the resin-filler base on the floor of the chamber or resin only. The material in the canals may be unpolymerized gel or incompletely polymerized “sap-like” resin, which can be removed with relative ease. In cases where fully polymerized resin is present, the material is brick hard and can be difficult to impossible to remove. At present, there is no solvent that has proven to be completely effective in facilitating fully polymerized RF resin removal.

By better understanding the formaldehyde-resorcinol materials and methods, dentists can make appropriate treatment-planning decisions for patients that present with this root canal treatment. If retreatment is indicated, the dentist must be prepared to expect various materials and presentations of the treatment within each tooth and even each canal.

This resorcinol-formaldehyde endodontic therapy is still practiced and is commercially available as Foredent from Dental AS in the Czech Republic.

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### References

1. Wu MK, Wang M. Clinical and experimental observations on resinifying therapy. *Oral Surg Oral Med Oral Pathol* 1986;62:441-8.
2. Matthews JD. Pink teeth resulting from Russian endodontic therapy. *J Am Dent Assoc* 2000;131:1598-9.
3. Lewis BB, Chestner SB. Formaldehyde in dentistry: a review of mutagenic and carcinogenic potential. *JADA* 1981;103:429-34.
4. Sikri VK, Sikri P, Singh J, Manjri M, Khanna S. Resinifying therapy in endodontics. II-Histological and bacteriological evaluation. *Indian J Dent Res* 1996;7:51-3.
5. Hata M, Shiono M, Orime Y, et al. Pathological findings of tissue reactivity of gelatin resorcin formalin glue: an autopsy case report of the repair of ventricular septal perforation. *Ann Thorac Cardiovasc Surg* 2000;6:127-9.
6. Casselman FP, Tan ES, Vermeulen FE, Kelder JC, Morshuis WJ, Schepens MA. Durability of aortic valve preservation and root reconstruction in acute type A aortic dissection. *Ann Thorac Surg* 2000;70:1227-33.
7. Sung HW, Huang DM, Chang WH, Huang LL, Tsai CC, Liang IL. Gelatin-derived bioadhesives for closing skin wounds: an in vivo study. *J Biomater Sci Polym Ed* 1999;10:751-71.
8. Nomori H, Horio H, Suemasu K. The efficacy and side effects of gelatin-resorcinol formaldehyde-glutaraldehyde (GRFG) glue for preventing and sealing pulmonary leakage. *Surg Today* 2000;30:244-8.
9. Robinson C, Hallsworth AS, Weatherell JA, Kunzel W. Arrest and control of carious lesions: a study based on preliminary experiments with resorcinol-formaldehyde resin. *J Dent Res* 1976;55:812-8.
10. doPico GA, Rankin J, Chosy LW, et al. Respiratory tract disease from thermosetting resins. Study of an outbreak in rubber tire workers. *Ann Intern Med* 1975;83:177-84.
11. Ongena K, Matthieu L, Constand L, Van Hecke E. Contact allergy to resorcinol monobenzoate. *Dermatology* 1998;196:470-3.
12. Chauvin P, Laaurian Y, David P, Laudenbach P. Tooth extraction without substitutive treatment in patients with severe hemophilia or other congenital disorders of hemostasis: importance of gelatin-resorcinol-formal glue. *Actual Odontostomatol (Paris)* 1984;Mar:81-93.
13. Foredent® package insert. Czech Republic: Dental AS.
14. Sikri VK, Sikri P. Resinifying therapy in endodontics. A clinical and radiological evaluation. *Indian J Dent Res* 1995;6:35-9.
15. Magid EA, Mukhin NA. Atlas for phantom course in therapeutic stomatology. Moscow Medicine, 1981.
16. Indzova K, Hajduska J. Microbiological study of extracted deciduous teeth with gangrene and periodontitis treated by the formalin-resorcinol method. *Stomatologia (Sofia)* 1983;65:1-4.
17. Kaminska-Litwin K, Waszkiel D. Clinicoradiographic evaluation of dental treatment using the extirpation method. *Czas Stomatol* 1983;36:721-4.