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ROSIN SOLUTION FOR THE SEALING OF THE DENTINAL TUBULI AND AS AN ADJUVANT IN THE FILLING OF ROOT-CANALS[1]

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℞ Rosin ..... gr. xll
Chloroform 3iij
M. Fiat sol.

Colophony, resin, commonly known as rosin, is obtained from turpentine by distillation. In the process the oil of turpentine comes over and the rosin remains behind. Rosin varies in color from dark red-brown to black or white, according to its purity and the degree of heat used in its preparation. Chemically, it is the anhydrid of abietic acid. It has the physical and chemical properties common to all resins. It softens at 176° F. and fuses completely at 275° F.; is insoluble in water; with difficulty is soluble in alcohol; freely soluble in chloroform, acetone, benzone, and fatty oils.

The rosin that is best adapted to dental uses that I have been able to find, is that prepared by Bernardel for the use of the violinist. A French preparation very near the color of dentin. The formula as given above makes a very thin solution. It required a long time for me to realize the advantage in the use of a thin solution. A thick mixture will not penetrate the tubules, nor does it give up enough chloroform to dissolve the gutta-percha.

You will agree with me in three statements:

First—That thermal changes due to the presence of large metallic fillings in tooth cavities excite conditions that cause the untimely death of many tooth pulps.

Second—That pulp capping has ceased to be a regular procedure in many offices.

Third—That a thoroughly satisfactory root-canal filling has not yet been proven.

[1] Read before the First District Dental Society, S. N. Y., Dec. 1, 1913.

It is my desire to discuss the use of a solution of rosin in chloroform in our treatment of the class of cases that the three statements suggest.

A moment's consideration of the three divisions indicate that we are to deal with dentin that has been subjected to infection. Therefore a brief rehearsal of the histological anatomy of dentin will aid us in getting our mental eyes in the same focus.

Arthur Hopewell Smith in his late book, "An Introduction to Dental Anatomy and Physiology," says: "The functions of dentin are to give substance to the tooth itself; to provide a center of sensation; to protect the pulp. Enamel is without the pale of nutrition. The pulp is highly vitalized and the dentin is on the borderline of the living and the dead: semi-vitalized, if one may so speak.

"Nature would not for a moment tolerate the presence in the midst of living tissues of a dead body like enamel. The result is therefore the presence between the living pulp and the inert enamel of a large area, relatively speaking, of a tissue which is marvelous and unique. In no other part of the body do we find an entirely tubular structure like dentin. Its peripheral parts where it joins the inorganic enamel and cementum are less vitalized than its central parts. This explains the reason why the dentinal tubules are not of the same caliber throughout their lengths. They vary from 1.7 μ to 5 μ. The diameter of the tube diminishes as it proceeds outward, until at the peripheral region of the tooth it becomes immeasurable. The dentin of the crown of teeth is more plentifully supplied with living material (protoplasm) than the roots; hence the tubes branch more frequently in the latter than in the former situation. The tubes carry the dentinal fibrils; that is the peripheral poles of the odontoblasts."

It is through these dentinal fibrils that nervous stimuli are transmitted to the pulp. Following the teachings of Miller and Black in the study of carious dentin, we note among other interesting things that caries progresses along the lines of the dentinal tubuli; that the form of the disintegrated dentin is that of a cone with the apex toward the

pulp chamber, and that the dentin is decalcified in advance of the penetration of the micro-organisms.

It is not likely that in the preparation of cavities we *always* remove the apex of the affected dentin. In deep-seated cavities is it advisable? In spite of the application of strong antiseptic agents recurrent decay may develop, and toxins finally reach the pulp.

If the remaining traces or thin layers of decayed dentin can be thoroughly dehydrated, the application of rosin solution may be of great service.

First, rosin being more or less a non-conductor, it reduces the shock of thermal changes, thereby lessening the tendency to secondary growths or deposits within the pulp chamber that are so noticeable under large metallic fillings, especially under large gold inlays.

We are taught that the decalcified dentin that is to be found just in advance of the micro-organisms in carious dentin furnishes food for the invading host. If the remaining decalcified dentin be saturated with rosin, I imagine the cost of living in that region will become prohibitive. However, if the rosin solution reaches the farthest boundaries of the decalcified dentin through the infected area, then the micro-organisms within the tubuli will have been engulfed within the rosin solution, and unless the bacteria are able to liquify the rosin, they will be forever inhibited from further activity, be they arobic or anerobic, in active or spore form. I need only mention the antiseptic properties of the chloroform.

This you will admit would be a very desirable condition in which to have a layer of decayed or decalcified dentin over the pulp, where the removal of the layer of decay would mean the exposure of the pulp.

The most satisfactory results that I have had in capping pulps has been to flow a rosin solution over the exposure, evaporating the chloroform with warm air, then cause a very thin cement to *flow* over the floor of the cavity and the thin coat of rosin and allow it to harden, being very careful to avoid pressure of any kind on the cement until quite hard.

This practice has been confined to quite small and recent

exposures. Not the least satisfactory use of the rosin. solution is after more or less thorough drying of the cavity and application of the rosin prior to the insertion of gutta-percha fillings either as a temporary or permanent filling.

On the removal of a temporary stopping of this nature that has been in place a week or a month, the decayed dentin that may have for any reason been left in the cavity will be found noticeably tough and hard and dry, due to the presence of the rosin, and the sensibility of the dentin will be materially less, showing that the dentin has been free from the irritating effects of acids, or, in other words, the fibrils have been in a state of comparative rest. And after all is said, the chief function of the surgeon is to remove the irritant and place the affected region at rest to the end that nature may perform a cure.

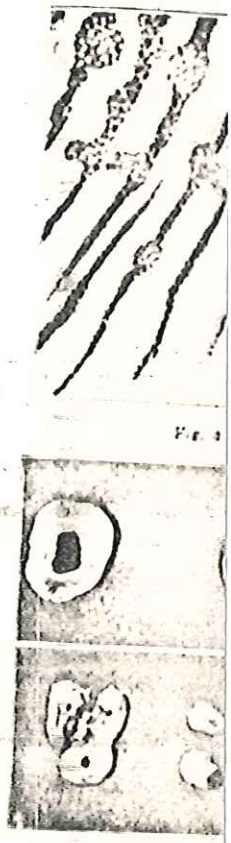
We now come to the consideration of the time-worn subject of root-canal filling. Let us not undertake to discuss the treatment of root canals preparatory to filling further than to say that no root canal is properly prepared for filling unless a fine paper canal dryer, as furnished us by the dealers, can be passed to or near the apical foramen.

In a devitalized tooth we are again dealing with infected dentin or with dentin in which the tubules will soon be filled with micro-organisms unless they be tightly sealed with a stable and compatible substance.

In a discussion read before the National Dental Association at Cleveland, July, 1911, recorded on page 218 of the official proceedings of that year, I gave the technic for filling of root canals with rosin chlora-percha and gutta-percha cones.

The record shows this statement: "A tooth treated in this manner *out of the mouth* and made into a thinly ground slide will show that the tubuli are filled to the cementum with rosin. The canal is filled with rosin and gutta-percha, a mixture that is hard and insoluble in body fluids, does not shrink and is compatible with the surrounding tissues, as is chloro-percha."

Further along in this paper I wish to modify this statement somewhat.



In the two years that have elapsed, almost constant observation and effort has produced improvement in technic and results. The improvement and better understanding of conditions is the result of having found a staining material that will carry with the solution into the tubuli and remain permanently with the rosin during the process of grinding thin sections of the dentin for microscopic inspection.

If possible, is it desirable or necessary that the tubuli be sealed?

Dr. Hermann Prinz, whom I regard as one of the foremost among our scientific research workers, said in a paper read before the St. Louis Dental Society, September 2, 1912: "If the canal is not filled perfectly, serum will seep into it from the apical tissues. The serum furnishes nutrient material for the micro-organisms present in the tubuli of a primarily infected root canal."

The dentin is traversed by dentinal tubuli which number from 25,000 to 30,000 to the square millimeter. The pulp in situ sends protoplasmatic processes into these tubuli, and is connected with the peripheral tissues by arteries, veins, and nerves which pass through the main foramen and a number of small foramina (usually 2–7) present in the apex of the tooth. According to Fischer these accessory foramina are found in about 90 per cent. of all permanent teeth. These anatomic facts are not sufficiently emphasized at present. Their significance is of great importance for the full comprehension of the pathology of secondary infection.

In an incipiently infected root canal, these dentinal tubuli and the small foramina offer ready hiding places for various forms of pathogenic bacteria.

After exhausting the nutrient material the bacteria become attenuated or they assume restive forms. If the tubuli and the foramina are tightly sealed, these enclosed bacteria must necessarily remain permanently confined in their lodging places, while, if the root-canal filling leaks, the seepage of serum furnishes fresh material which offers excellent opportunity for their renewed activities.

By continuity this secondary infection spreads along the

lines of least resistance, *i.e.*, toward the apex, and finally reaches the pericementum. This tissue protects itself against the invading foe by a reactive inflammation which results in the production of a fungus growth known as a granuloma, or, in the past, as the abscess sack or pyogenic membrane.

For years the enclosed bacteria may remain dormant. At the slightest provocation, however, overexertion, a cold, increased blood pressure, lowered vitality or some other cause, they may assume a most virulent activity, resulting in the production of the so-called subacute abscess. Based upon this supposition, we are able to furnish a plausible explanation of how these obscure secondary abscesses occur about the devitalized teeth which at one time were pronounced cured.

In one of the most profound papers given to the dental profession on mouth infection, Dr. Rhein says: "Unfortunately as a profession we must admit that most of the cases of blind abscess are the results of imperfect dental operations. In some cases they may be the result of bad judgment on the part of the operator; in others they may be due to ignorance and incompetence, but a very large number of cases are attributable to the failure of the educated dentist to give the time needed to perform an aseptic operation and have the field absolutely free from the possibility of future infection. This is absolutely nothing short of malpractice when done by a dentist who knows."

We have the testimony of several investigators to the effect that it is possible to sterilize the root canal proper, but it is an impossibility to sterilize infected dentin of a tooth while it remains in the mouth.

The microscope and the culture media have shown us conclusively that we have been, and are now, leaving enormous numbers of micro-organisms within the body with a more or less available route ~~open to the~~ circulatory system where they may reach any part of the body carrying destruction to those organs or parts that may offer the most attractive lodging place.

A most significant fact must be borne in mind in regard to the devitalized dentin. We have no blood current to assist in

the struggle. The dentin has absolutely no power even to assist in repair. No granulation or scar tissue—nothing but an inert tubular mass infected by millions of toxin-producing micro-organisms. We must make of this infected tubular mass an inert harmless and stable body, including the effective closing of the numerous foramina, to the end that nature may be able to envelop the root mass in a healthy and vigorous peridental membrane that the tooth may serve its several useful purposes for a number of years.

Most of us have at one time or another shared in the opinion that what the root canal might be filled with mattered but little.

The radiograph in the hands of the advanced dental practitioners has brought to light evidence sufficient to prove to the dullest of comprehension the fallacy of such an opinion. It does matter as to the material: it does matter as to the manner of placing the material in the canal. The matter of prime importance being the sealing of the more or less numerous foramina, and, as we have no assurance that all the foramina in a given root canal are located near the apex, it becomes our duty to seal the whole length of each canal with a material that will search out and seal minute canals or openings that, owing to physical conditions, we are unable to see.

Have we a root-canal filling material that will meet the requirements indicated above? We have three that may be considered. Gutta-percha and chloro-percha in combination, paraffin, as advocated by Dr. Hermann Prinz and Dr. Dunning and the combination of rosin and gutta-percha. With the gutta-percha cone and chloro-percha you are quite familiar. We know of many successes as well as of many unhappy failures with this root filling, sometimes due to faulty manipulation, but often due to the fact that the root-canal filling has shrunken sufficiently to admit body fluids to the canal or permit the egress of the micro-organisms that infested the tubuli, and in addition the gutta-percha root fillings are often found to be saturated with decomposed and odoriferous substances that we are altogether too familiar with.

The paraffin root-canal filling, as advocated by Dr. Prinz

and Dr. Dunning, has many attractive features, and time may prove it a most, if not the most, acceptable root filling. I have not always succeeded in getting the paraffin to the apex of the roots of upper teeth. If the wire is too hot the paraffin will collect about the shank of the instrument, and if not hot enough it does not flow to all parts of the canal. The melted paraffin will, however, follow the paraffin oil into the tubuli and foramina if treated properly. It will take time to prove its permanence within the body. Our previous experiences and the experience of the surgeon have made us a little shy on this point.

The technic of the rosin-gutta-percha root filling is simple, easy, quick, and sure to seal all tubuli and foramina that are open.

I have said that a root canal should be the general shape of the paper root-canal driers as furnished us by the dealers. In addition to this general form, have the mouth of each canal a decided saucer shape. This will facilitate the placing of agents or instruments to or near the apical foramen. The first step then is the complete dehydration of the dentin, using acetone, as advised by Dr. Prinz, as the dehydrating agent. After flooding the canal with acetone, use the paper points liberally until the canal is entirely free of moisture. Follow this with warm air. Then hold a warm wire in the canal for a minute or two, being careful that the wire is not hot enough to scar any part of the canal.

Right here is where many root-canal operations fail. The canals and tubuli must be as dry as it is possible to make them, bearing in mind that it is possible to do damage by overheating the root.

Now flood the dry root canal with the thin rosin solution, pumping it in with a wisp of cotton on a broach. When the canal is full of the solution, pass a fine wire or broach to the end of the canal. Work out all the air that may be trapped therein. This is of vital importance.

Select a gutta-percha cone that will reach to or near the end of the canal, holding the cone with a fine foil carrier, and pass the cone carefully and surely about half way into the

canal, pumping the cone up and down in the canal usually from forty to sixty times, and, as it dissolves in the chloroform, advancing the cone farther toward the apex.

The pumping motion forces the rosin solution farther into every opening. The chloroform at the same time dissolves the periphery of the gutta-percha cone which, becoming more and more attenuated, slips farther toward the apex, surrounding itself with a mixture of gutta-percha and rosin. The rosin seals the tubuli and at the same time causes the gutta-percha to stick tight to the pulp walls, and makes the gutta-percha more stable and proof against the action of body fluids or substances.

If this does not leave the large end of the gutta-percha cone at or near the end of the canal, place a small cone alongside or on the first one; then, with cold steel plugger points that will go into the canals, gently pack the mass into the canal, using warm air to soften the protruding gutta-percha if necessary.

This packing forces the semi-fluid (chloro-percha and rosin) into unknown canals and pockets, and at the same time brings the surplus chloro-percha to the mouth of the canal, where it may be taken up with absorbent rolls or cotton.

In multi-rooted teeth complete the filling of each individual canal before starting another.

Rub the steel plugger points on paraffin cake to prevent the partially dissolved gutta-percha from adhering to the instrument. The pulp chamber is to be filled with one of the cements.

You may ask: "Do you succeed in filling *all* canals and tubuli to the farthest extremity?" No; only those that are open and dry to the farthest extremity.

Are we likely to have inflammation in the periapical region following the closure of root canals in this manner?

The probability of inflammatory conditions in all cases depends upon the ability of the operator to read the pathological signs of each individual case and his skill and delicacy of touch in the manipulation of the various agents used.

Rosin and chloro-percha and cone is superior to chloro-percha in three ways. First, the rosin in chloroform pene-

trates deeply into the tubuli and foramina that chloro-percha will not enter at all, leaving within such tubuli or foramina, upon the disappearance of the chloroform, a more or less solid, inert, insoluble substance that enmeshes the contents and seals the lumina of such tubuli or foramina. Second, the rosin and chloroform causes the gutta-percha, in whatever form it may be applied, to adhere closely to the walls of root canal or cavity. Third, the incorporation of the rosin in the freshly made chloro-percha makes an unshrinkable and impervious mass about the gutta-percha cone. If gutta-percha and rosin be dissolved in chloroform and left in an open dish or tube to dry or solidify, the rosin will rise to the surface and harden in a crust over the gutta-percha. When the mixture is made in the root canal, as has been suggested, the rosin in solution is held firmly in place in the dissolved gutta-percha between the canal wall and the cone in the center.

We must be prepared to meet all sorts of morbid anatomical changes in the pulp chambers, root canals and the dentinal tubuli, due largely to constructive irritations long present in and about the tooth.

The slides that I shall show on the screen are selected, each one, to assist in demonstrating that the teeth which require root-canal treatment are, as a rule, far from being the perfect anatomical specimens that we see illustrated in our text-books. A tooth that has lost its pulp has usually been subjected for a long time to those conditions that bring about destructive as well as constructive changes.

The rosin solution does not show in X-ray pictures until mixed with gutta-percha, when it shows very plainly in the canals and foramina, but not in the tubuli. Chloro-percha will not enter the tubules; bismuth oxide does not dissolve in chloroform, and therefore does not enter the tubuli; the blue stain spoken of enters the tubuli with the chloroform and rosin solution, but does not show in X-ray pictures; so, in order that we might have some visible evidence of the diffusibility of the rosin solution through the dentin, I have resorted to color photography.[2] To vouch for the correctness of the pictures, I have the original specimens here for comparison.

[2] See frontispiece.

One better versed than I in laboratory technic could certainly work out a more satisfactory scheme than this.

The pulp canals of a number of extracted teeth were opened mechanically—that is with burs and drills—dehydrated and pumped full of the rosin and chloroform that had been stained blue. Then the gutta-percha cones were used as has been described above.

I do not claim that this procedure gives an exact reproduction of conditions in a tooth canal while the tooth is yet in service in the mouth. I do claim that the specimens and the pictures give a clear and understandable *basis* from which we can work toward a reasonable ideal.

These slides are shown more to explain the theory than to prove results. There is a vast difference between filling a root canal in an extracted tooth and one in situ.