

## CONTROL OF PULP HÆMORRHAGE: A FACTOID

This FACTOID discusses devices & agents that have been used for hæmostatic control of exposed & bleeding vital dental pulps, which may or may not have been inflamed before the exposure occurred, or bleeding at the time of exposure.

Historically, hæmorrhage control was related to trauma that involved massive arterial blood loss causing rapid death—the first concern was to secure a firm **tourniquet** & apply direct pressure to prevent massive blood loss. If direct pressure is difficult to maintain, then a **compression dressing** is the next choice—taking care not to push debris into the wound site. For non life-threatening bleeding—solid fibers, sponges, polymers, ceramics, composites & liquid biosynthetics are used.

The vital human pulp is a unique **LOW COMPLIANCE TISSUE** being rigidly bound within the dentine covering shell—there is **no space for the pulp to expand** during any stimulation—whereas the external skin—if pinched—is highly compliant since it is easily manipulated without any restriction. All pulp vessels—arteries & veins—enter & exit through the small root apex surrounded by root cementum. These vessels project from the rich vascular vessels that feed into the alveolar bone & into the thin periodontal ligament space of cells, collagen & oxytalan fibers.

The arteries of the pulp have unique arteriole-venous (AV) shunts that can rapidly open to immediately re-route the high-pressure arterial blood directly back into large veins & out through the apex—without traveling through peripheral arterioles & venules—this AV-shunt system rapidly relieves vascular arterial pressure on the peripheral vessels of the odontoblastic cells—**the tooth pulp is a totally unique low compliant tissue.**

The dental literature reports many devices & agents that have been used to stop bleeding of exposed vital pulps—normal or infected. **A number of factors must be considered when applying agents to a pulp exposure: its irritating property, its toxicity, its solubility, its tissue penetration, its absorption capacity, its chemical reactivity with proteins & other tissue substances.** The germicidal activity of most agents is greatly reduced in the presence of blood serum & extracellular factors—the reduced antiseptic activity is so great that it loses—for all practical reasons—its original intended value.

## HÆMMORHAGE & ANTISEPTIC AGENTS USED ON PULP EXPOSURES

**Red Hot cautery by a metal wire** is only of historical note. Generally a small thin wire of gold or silver was heated to red hot & touched to the bleeding pulp. It did stop the bleeding but caused brutal pain, as well as leaving dead cell debris behind the wire path that often leads to increased infection, impaired healing & necrosis.

**ELECTROCAUTERIZATION** is usually accomplished by a device that uses electricity to direct some sort of energy to the tissue as an electrical pulse that may be of elevated heat or electrical spike. This creates a subjacent tissue-char & necrosis that simply increases the probability of infection & damage to the edges of the vital lesion—leading to prolonged & impaired healing & necrosis. As you know from a previous **PULP FACTOID**—the vital dental pulp is a **UNIQUE LOW COMPLIANT TISSUE** being encased in rigid dentine. Consequently, the remaining char & necrotic debris hinders the proper healing probable.

**LASERS – Light Amplification Stimulation Emission of Radiation**—are emissions of electromagnetic radiation of visible light that cause rapid charring of organic & mineral tissues. **LASERS** will stop pulp bleeding, but they leave a solid carbon-char residue that remains in the tissue, **without** undergoing normal biological removal. Besides being expensive to purchase, they require an external power source, **LASERS** kill vital cells & disrupt the extracellular pulp stroma, which often delays the healing process.

**Tannic acid** (poly-phenol) is a form of tannin that is based on Gallic acid & glucose esters, being a light brown to yellow powder, highly soluble in water with some anti-bacterial properties. It is a basic ingredient in the staining of wood, found in the bark of redwood & other trees. Tannic acid was used as medical treatment for poisoning by such toxic substances such as strychnine, mushrooms & ptomaine poisoning during World Wars I & II. **By the way—the old wives tale that a tea bag will stop bleeding of an extracted tooth is exactly that—Green tea bags DO NOT contain tannic acid & DO NOT slow down bleeding at an extraction site.**

**Phenol** is an acidic carboic acid that produces a toxic **Bis-Phenol-A** compound when joined with acetone. It is **corrosive** to the eyes, skin, & respiratory tracts causing edema. Some cosmetic salons use it as a skin exfoliate due to its caustic sloughing of

the outer epithelial layer. Antiseptic capacity of phenol is very low in the presence of blood serum & when high concentrations are used to increase its antiseptic value, it is destructive to healthy tissues, impairing healing & causing scar tissue formation.

**Iodine** (I) is a halogen of purple color & a valuable antiseptic generally used for the disinfection of skin & the topical cleansing of the tooth surface after rubber dam placement, however, its antiseptic value is very slight, especially when used for the treatment of deep wounds, due to its coagulation of protein & irritation to normal tissues. The tissue penetrating capacity of iodine is so poor, that when wounds are liberally treated, they tend to form a permanent scar than without its use.

**Ferric chloride** ( $\text{FeCl}_3$ ) is also called iron chloride & when dissolved in water gives off heat of reaction. It is a brown to yellow acidic corrosive solution, also used as a coagulant & is a mild oxidizing agent that is an etchant for copper-based metals in electrical circuit boards.  $\text{FeCl}_3$  is acidic, toxic & highly corrosive. Anhydrous  $\text{FeCl}_3$  is a powerful dehydrating agent. Several vital pulp studies using  $\text{FeCl}_3$  agents have shown persistence of precipitated iron particles in the extracellular stroma of the vital pulp. Besides elevating pulp temperature the  $\text{FeCl}_3$  particles have also been shown to remain for several months without their removal by neutrophil cells or lymphatic drainage.

**Mercuric chloride** ( $\text{HgCl}_2$ )—also called calomel—is a minor antiseptic & is quite irritating to vital tissues when placed in dilute concentrations & so it must be considered as none to poor in any sort of germicidal value. It does not disinfect the necrotic & dead white cells (pus) that have ingested dead bacteria or cells; other wound debris & may ultimately cause permanent scar tissue formation.

**Hydrogen peroxide** ( $\text{H}_2\text{O}_2$ ) has a low antiseptic value against many microorganisms & only has slight value against anærobic bacteria, which tend to be located in the superficial infected dentine zone & the subjacent infected pulp. It has been documented that  $\text{H}_2\text{O}_2$  has excellent—although briefly effective—antiseptic value to kill bacteria in a test tube. However,  $\text{H}_2\text{O}_2$  has very little antiseptic value when it is directly used on wounds, since it is rapidly decomposed by the enzyme catalyses that are always present in blood cells & vital tissues. Some studies have reported the

mechanical “detergent” action of atmospheric oxygen (O) gas has a greater antiseptic value when compared to the liquid form of H<sub>2</sub>O<sub>2</sub>.

**Epinephrine** is a naturally occurring body hormone from the adrenal gland—also called adrenaline in some European countries—that increases heart rate, but contracts peripheral blood vessels & dilates air passages. It is used as a drug to treat cardiac arrest to increase cardiac output. It is the drug of choice to treat anaphylaxis & also for treating certain variants of *in vivo* sepsis. In dentistry, epinephrine is used in the local anæsthetic solution to retard (slow down) the absorption of the anæsthetic (lidocaine) by local tissues & thus prolonging the action of the anæsthetic agent. Clinicians have used epinephrine to attempt to control excessive pulp bleeding as it has some direct contraction effect on pulp vessels, but it has limited effect & it lacks an effective antiseptic property, nor does it enhance the removal of debris from the cavity or subjacent pulp. We have all seen old movies (Dinero in Raging Bull) in which the trainer wipes epinephrine onto a boxing cut to stop bleeding about the eyes & face during the match, but it is only momentary & bleeding re-occurs with slight trauma.

**Formocresol** (FC) was originally formulated by Dr. J. Buckley in the late 1800’s, in which he showed that it rapidly stopped all nerve transmission (patient pain) & served as a minor germicide, but it also killed vital pulp cells & left a layer of dense debris that inhibited healing. Many biocompatible *in vivo* studies have shown that FC & its chemical variants of formaldehyde (F), glutaraldehyde (GTA) & phenol (P) are toxic to vital cells at low levels & when placed into a vital organism, it has been shown to become bound to the proteins of most body organs.

**Sodium Hypochlorite** (NaOCl) has a **higher antiseptic value** to all of the above-discussed agents. NaOCl has many desirable qualities such as hæmorrhage control, cell debris removal from cavity walls & within the subjacent vital cells, biofilm removal & dentine chip removal from the subjacent pulp. However, ordinary NaOCl solutions tend to be quite variable in their composition due to their free alkali & chlorine components, which depending on concentration & pH may be slightly irritating when directly applied to wounds. It should be noted that the simple mixing of NaOCl with certain polybasic salts may stabilize the neutrality of the final lavage solution by

changing the relative proportion of the two or more salts contained in the final solution. Quite frankly, this is the logical clinical use of BioVAGE's diverse biological & lavage successes during pulpectomy & exposed pulps.

Various *In vivo* laboratory animals studies have shown that a 0.5% i.v. injection of NaOCl in animals that are infected with diphtheria or tetanus bacillus, as well as when infected with specific *in vitro* bacterial cultures of *B. perfringens* & *S. pyogenes aureus* --- **NAOCL CAUSES NO ILL EFFECTS TO VITAL EUKERATIC CELLS**. Consequently, an i.v. injection of NaOCl is therapeutic by delaying bacterial growth as well as destroying their toxins so as to inhibit & destroy their natural resistance.

## CLINICAL CONSIDERATIONS

**A bleeding dental pulp must not be treated like all other typical bleeding of any other soft high compliant tissue.** Since the vital dental pulp is a low compliant soft tissue encased in a rigid shell of enamel & dentine, the exposure site **should be allowed to bleed for several minutes**. Please remember, it is **counter productive** to place heavy compression against the pulp exposure site to arrest its bleeding---since the pulp is a **LOW COMPLIANCE TISSUE**—open bleeding actually promotes the normal flushing through the exposure site of any residual dentine cutting debris, dead cells from the inflammation process as well as bacteria with their toxic components.

When BioVAGE<sup>®</sup> is placed directly onto the cavity preparation it completely breaks down the organic biofilm—composed of bacteria or vital cells that may have become lodged onto any of the surfaces from the cavity walls as well as any other extracellular salivary proteins—they are all easily removed when rinsed with sterile water.

*In vivo* biocompatibility studies (Hafez-Quint Int 2000, Calderon-AAPD 2007) have shown that the effect of the BioVAGE<sup>®</sup> on an exposed pulp will provide complete removal of all organic debris by lavage & rinsing with sterile water to wash debris from the surface & subjacent cell stroma as well as to create a mechanism for the washing of dentine chip debris from the tissue surface as well as dead cells from the tissues, without causing any damage to the adjacent vital pulp cells, nerves or to the peripheral layer of primary odontoblasts.