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Mini Review

Theory of Optimum pH for Pulp Vitality: A Clinical and Experimental Theory of Endodontics

Pheiroijam Herojit Singh*

Department of Pediatric and Preventive Dentistry, Jaipur Dental College, Jaipur, Rajasthan, India

***Corresponding Author:** Pheiroijam Herojit Singh, Department of Pediatric and Preventive Dentistry, Jaipur Dental College, Jaipur, Rajasthan, India.

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Abstract

The dental pulp is enclosed by hard tissues of the teeth and is kept isolated from the oral micro-organisms. This vital tissue gets exposed to oral micro-organism either through dental caries, trauma induced fractures or cracks, attrition, abrasion, scaling and root planning procedures or micro-leakage from restorations. In periodontal diseases, micro-organisms may access dental pulp via dentinal tubules at cervical region or lateral and apical foramina. The exposed dental pulp will undergo inflammation and necrosis and finally infected. The time taken from exposure to infection is unpredictable and is usually a slow process. The theory of optimum pH for pulp vitality concerns more on intracanal changes in the optimum pH for pulp vitality at the time of pulp exposure.

Keywords: *Dental Caries; Dental Pulp; Dentinal Tubules; Infection; Optimum pH*

Introduction

The dental pulp is the vital tissue present inside the tooth. This tissue is supplied by the blood vessels which enter the apical foramen. The tooth will remain vital unless the pulp becomes infected with oral micro-organisms. The micro-organisms present in the oral cavity can gain access to the dental pulp through dental caries, trauma induced fractures or cracks, attrition, abrasion, scaling and root planning procedures or micro-leakage from restorations. These oral micro-organisms and their toxins may enter the pulp chamber through dentinal tubules or lateral and apical foramina. Endodontic pathosis is primarily caused by infectious agents that mediate a series of inflammatory and immunological responses in the dental pulp and periapical tissues.

The dental pulp may be subjected to a number of threats such as microbial, physical, chemical, trauma and iatrogenic. The most common cause of pulp diseases is due to micro-organisms and their toxins. The classic study by Kakehashi., *et al*. [1] proved that exposed pulps in gnotobiotic (germ free) rats did not become inflamed, whereas similarly exposed pulps in rats with a full oral flora became inflamed. Dental caries and the pulpal inflammation beneath it are clearly microbial in origin. Pulpal injury beneath restorations is mostly microbial and not due to cytotoxicity of the materials. Microorganisms and their byproducts enter between the restoration and the dentin as a result of microleakage [2-4]. The toxins from the carious lesion reach and affect the pulp well ahead of the microbes themselves.

Theory of optimum pH for pulp vitality

The theory of Optimum pH for pulp vitality states that the degeneration of dental pulp tissue is due to alteration in optimum pH level for pulp vitality and not due to infection. Degeneration includes inflammation, necrosis and death of pulp tissue. Infection of dental pulp

tissue is always secondary and is preceded by lowering of optimum pH level. Oral micro-organisms favor to grow in acidic environment. When dental pulp is exposed to alkaline substance of pH higher than optimum pH for pulp vitality, inflammation and necrosis of the exposed pulp occurred but without infection. Hence, the viability of dental pulp tissue depends on the maintenance of optimum pH level. Dental pulp is alkaline in nature. This optimum pH level also regulates the pulpal blood flow. The change in optimum pH level also depends on the sudden change of temperature and pressure. This explains why there is pulpal inflammation due to heat generated during cavity preparation and excessive pressure during orthodontic tooth movement. When pulp gets exposed such as in deep caries, there is lowering of optimum pH level for pulp vitality by the saliva which is acidic in nature. Presence of micro-organisms and their toxins from carious lesions has made saliva more acidic. The exposed portion of the dental pulp towards the carious lesion gets lesser pH level than the remaining portion. As a result, this portion is more prone to get inflammation and then infected with micro-organisms. Due to continuous production of toxins by the micro-organisms which are acidic in nature there is further lowering in the pH level and as a result of which the remaining portion also gets inflamed, then infected and degeneration continues. However, the above process is usually slow and unpredictable. In pulp therapy such as direct and indirect pulp capping, a layer of calcium hydroxide is placed over the exposed or nearly exposed pulp to maintain the optimum pH level for pulp vitality. In a traumatized tooth with intact crown there is disruption of blood supply to the dental pulp tissue. As a result, the alkaline optimum pH level of the pulp changes from its alkalinity to acidity due to reduce pulpal blood flow which makes the pulp tissue more prone to infection. Inside the pulp chamber degeneration of pulp started first from the coronal portion towards the apical portion. As long as the alkaline optimum pH level of the dental pulp is maintained the pulp will remain vital without any infection even in the presence of micro-organisms. Dental pulp tissue cannot restore its optimum pH by itself; however, it can restore its optimum pH in the presence of a medium with higher pH such as calcium hydroxide. This also explains why alkaline materials such as calcium hydroxide, Mineral Trioxide Aggregate (MTA), chlorhexidine (CHX) have antimicrobial property. During clinical studies on vital teeth isolated with rubber dam, dental pulps were exposed with sterile dental burs and pH values were measured with a pH meter. The pH of dental pulps of these teeth was estimated to be between 7.35 and 7.8. However *in vitro* studies have shown that proliferation of dental pulp cells occurred at alkaline pH of 9.5. Hence the rationale of all endodontic treatments should be to maintain the optimum alkaline pH level inside the pulp chamber. If pulp diseases are due to infection then antibiotic therapy alone would have treated but they are not so. In apexogenesis, for example, placement of alkaline material such as calcium hydroxide alone can maintain the vitality of remaining pulp tissue thereby inducing root formation without antibiotic therapy.

The theory of optimum pH for pulp vitality was postulated by Dr. Pheiroijam Herojit Singh of Jaipur Dental College, Jaipur, Rajasthan, India. It was based on the clinical and experimental findings. Evidences that supported this theory are given below:

1. In apexogenesis a layer of calcium hydroxide is placed over the amputed dental pulp to allow the remaining vital pulp to induce root completion. In this procedure the alkaline substance i.e. calcium hydroxide is placed to maintain the optimum alkaline pH of the dental pulp.

2. Most of the irrigating solutions used in Root Canal Treatment (RCT) are alkaline in nature.

3. Most of the endodontic materials are alkaline in nature.

4. Glass ionomer cements are acidic and hence avoided in deep carious tooth as restorative material without a base or a liner.

5. In pulpectomy the obturation materials are alkaline.

6. RCT remains successful even when gutta-percha is replaced with an alkaline material such as calcium hydroxide as obturation material.

7. In apexification, calcium hydroxide or MTA are used which are alkaline.

8. In an invitro study by Hirose Y., *et al.* mild proliferation of dental pulp cells occurred at pH of 9.5 whereas an acidic extracellular pH condition is associated with growth arrest or cell death [5].

9. EDTA (Ethylene Diamine Tetraacetic Acid) is used as chelating agent in root canal. It is acidic and has no antibacterial property. But buffered EDTA (17%, disodium salt, buffered to pH of 7.5) has antibacterial property.

Conclusion

When dental pulp gets exposed to oral environment, the first reaction to occur is the lowering of optimum pH level for pulp vitality. The maintenance of this optimum pH level is important for pulp vitality. For any inflammation of pulp to occur there must be alteration of optimum pH for pulp vitality. In order to restore this optimum pH and to maintain pulp vitality a layer of bio-compatible alkaline dental material of high pH such as calcium hydroxide, MTA has to be placed over the exposed pulp before pulp necrosis. The above theory describes why endodontic dental materials are made alkaline and offers great success in pulp therapy in clinical practices.

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