PRINCIPLES AND CURRENT METHODS IN THE TREATMENT OF DENTAL WOUNDS

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Keywords: *dentine wounds, pulp vitality, filling material, dental adhesion*

Abstract: *The following main goals should be considered in the treatment of dentine wounds: removal of infected tissue, stopping evolution of dental caries, maintenance of pulp vitality, avoidance of relapses and restoration of affected functions - for as long as possible. In other words, we must consider removing the affected tissues and preparing special cavities, choosing a filling material to restore and integrate as biologically as possible into the remaining dental structures. For this purpose, in addition to the functional characteristics of dental tissue, we must consider the choice of an application technique that promotes the best adhesion to the dental structure, which can ensure the long-term success of direct restorations.*

The dentine wound results from the action of any manual or rotary cutter that is used during cavity preparation.

The biological bond between the dentin and the pulp is so tight that literature refers to the "pulp-dentinal complex". For this reason, dentin damage by dental caries or by the action of chemical substrates in the composition of the filling materials can have ample effects on the dental pulp. The approach to biological treatment should take into account the biochemical composition of the dentin: 70-80% mineralized tissue, with an organic component of about 8% (mainly collagen fibers) and 12% water, but also the proximity to the dental pulp.

The structure of the dentin is traversed throughout the thickness (from pulp to enamel) of highly branched dentinal canals. They are more frequent and with a larger lumen near the pulp and narrower and smaller in the junction with the enamel. Channel density varies with the age of the patient. In young people, the number of canals and their lumen is higher than in the elderly.(1) Also from the structure of the dentin we have to keep in mind that the collagen fibers are richer represented in the surface dentin, while the water is better represented near the pulp.

Against the aggression of dental caries, dentin reacts in three ways in order to protect the pulp:(1,2)

- Limiting the dentinal permeability by reducing the lumen of the canal, due to intratubular dentin,
- The formation of secondary dentine of reaction by increased dentin secretion, but its deposition is less organized than the primary dentin,
- An inflammatory and immune reaction that tends to neutralize or eliminate some of the bacterial aggressive factors.

In the treatment of dentine wound, consideration should be given to the general wounds in the body as follows:

- Lack of bleeding - beneficial by the visibility offered but with drawbacks in terms of blood defense mechanisms,
- Direct exposure to the pathogen agents in the oral environment or to the substances from the filling materials,
- Presence of pioneering bacteria in dentinal canal,
- The presence of the dentinal liner (clear liquid lacking figurative elements but favorable to bacterial growth).

During the removal of affected tissues, with the rotary instrument, a temperature rise of 10-20 ° C may occur. This can trigger irreversible histology changes if the preparation is done without cooling pauses and / or is operated with high pressure or damaged rotary instruments.

Another factor that acts during cavity preparation is dentine desiccation. This can produce, in case of excessive drying for more than 20-30 seconds, a suction of the odontoblastic cores in the dentinal canal, which will cause their death. Excessive desiccation is also harmful to dentinal adhesion because it produces collapse of the free collagen fiber network obtained by demineralizing the dentine.

In addition to the factors mentioned in the treatment of dentine hoods, a number of chemical substances interfere with: ortho-phosphoric acid, eugenol, poly-alchenoic acid, present in many restorative materials, which if the residual dentine layer is less than 0.5 mm have toxic effects on pulp. In addition, saturation strengthening during polymerization of resins induces a wall stress phenomenon that materializes at the micro-dehiscence wall interface and which in turn favors the marginal micro infiltration.(2)

Modern dentine wound treatment should take into account, in addition to these factors, the presence of smear layer. This is a relatively smooth amorphous organic film of 1-2 micron thickness, made up of denatured collagen fibers, incorporating hydroxyapatite crystals. By denaturation, collagen is transformed into an amorphous gelatin mass, which covers canal entry but also inter-tubules substance. If dentin milling occurs in overcoat and without cooling, it can reach a temperature that can even deform apatite crystals.

Smear layer cannot be removed from the cavity walls by the water-air spray. To some extent, it can be removed from sodium hypochlorite and hydrogen peroxide used in the dentine wound toilet. After a certain period of time, either due to organic acids or due to the friction forces developed at the critical interface, the smear layer disappears. Instead there will remain a 1-2 μm dehiscence that will allow subsequent infiltration of toxins, bacterial enzymes or even bacterial cells.(2)

The current treatment of dentine wounds should take this phenomenon into account and combat it by various means. These essentially consist of modifying the physiochemical properties of smear layer, creating a new hybrid layer with hybrid properties (dentinal wound hybridization).

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Article received on 07.05.2017 and accepted for publication on 31.05.2017
ACTA MEDICA TRANSILVANICA June 2017;22(2):92-93

By hybridization, the permeability of the wound is reduced; the elasticity of the dentin layer is reduced, which brings it closer to the elasticity coefficient of the restorative material. At the same time, it is favored to create particularly strong chemical bonds between the collagen fibers and the fluid resin that infiltrate them. The smear layer measures address two major desires of dentine wound treatment:

- Active (biological) protection – local defense, pulp-dentinal mechanisms with antimicrobial and dentin-genetic effects are stimulated,
- Passive protection by creating an inert barrier that isolates the pulp from the oral environment.(3,4)

Reaction of the pulp in slow-moving caries consists of the formation of secondary reaction dentin (it is a new repair dentin). It is characterized by the following biological processes: a slightly inflammatory response in the first three days, after which new odontoblaste cells that synthesize precolagen are differentiated. It will produce collagen fibers that attract and precipitate mineral salts in the bloodstream.

The first secondary dentine bridges occur after about 13 days and the training rate increases for 1.5 months at a rate of 3.5 μm / day.(4,5,6)

In order to combat micro infiltration and to achieve adhesive restorations, it is necessary to achieve correct dentinal wound hybridization.

This can be achieved through two different therapeutic strategies:

1. Increasing the cohesion of smear layer by impregnation with primers and monomers,
2. The complete or partial removal of smear layer by etching followed by washing, or by self-etching and retention of smear layer or by dentin conditioning with weak acids.

In the case of smear layer removal, the fluid resilience will penetrate into the canals at a certain length, which will lead to an increase in mechanical adhesion.

Curative sealing of dental plaque as a biological target to block the penetration of pioneering bacteria and their products into the pulp accession. In the canal will form fluid resin caps, which by polymerization will interrupt the displacement of the lining inside the canals, so that leads to the decrease of the dentinal sensitivity. It is considered that the demineralization of dentin for 15 seconds with 37% phosphoric acid does not distort collagen fiber, which gives the possibility of chemical bonds between hydrophobic resins and hydrophilic dentine. The factors that depend on the efficiency of hybridization are:

- an insufficient demineralization of the dentin,
- an excessive demineralization of dentin,
- incomplete polymerization of the monomer,
- application and diffusion time until polymerization is insufficient (minimum 20-30 seconds),
- the difficult penetration of primers based of alcohol or acetone in excessive desiccated dentine,
- painful reactions to acid or adhesives (hypertonic solutions),
- failure to comply of the work protocol.

By hybridization, a dentine layer with different properties to healthy dentin is obtained having a less elastic modulus than the non-hybridized dentin. This property will cause the new layer to absorb part of the mastication and the resulting polymerization shrinkage. It appears that self-etching primers result in a hybrid layer of only 1-2 microns compared to 3-stroke techniques that require application and then washing the acid and which gives a thickness of 3-7 microns for the hybrid layer. Consequently, adhesion may be different in these cases. The durability of adhesive bonding depends on the following factors:

- partial thickness of the hybrid layer,
- the hydration curve of the demineralized dentin,
- the degree of monomer polymerization, the collagen embedding capacity,
- decisions caused by non-compliance with the work protocol.

Effective sealing of the dental wound results in 2-10 months and the annihilation of pioneering bacteria from the dentinal canal.(2,3,6) No filling material is universal, and its correct choice is essential for the longevity of the filling and equally to preserve the pulp's vitality. In this choice we have to consider the following aspects:(7,8)

- If it has the ability to protect the remaining dental structure from the exerted mechanical forces - comparable coefficient of elasticity,
- If it can be retained at the rest of the structure,
- If it prevents secondary caries,
- If it stimulates the remineralization of the remaining tissues and forming of secondary dentine,
- If it has a physiognomic appearance.

Conclusions of current studies on wound healing reveal a particular importance of the dentine layer left over to pulp tissue. No restorative material offers a better protection for the pulp then the remaining dentine. Thus 0,5 millimetres of remaining healthy dentine reduces by 75% the effects of toxic bacteria's on the dental pulp and one millimetre of residual dentin has the ability to reduce by 90% the toxic bacterial effects. Preservation of the remaining dentin layer is more important for the pulp than replacing the lost tissue with restorative plastic material.(4,9,10)

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