SCIENTIFIC REPORT

Ionolux – *In vitro* study of the pre-conditioning of dentin

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Both resin-modified and pure glass ionomer materials come with a self-adhesion to the tooth, but the additional conditioning of dentin with polyacrylic acid is still being considered and discussed. This study investigated how the different treatment protocols of the dentin affect the bond between dental hard tissue and resin-reinforced glass ionomer material.[1]

Resin-reinforced glass ionomer materials combine the advantages like e.g. stability and durability of composites with the self-adhesion and the high biocompatibility of glass ionomers. Despite many years of use in daily clinical practice, there are hardly any studies on which pre-conditioning method of dentin provides the best adhesion.[1] The conditioning with polyacrylic acid is advertised by some manufacturers, but frequent failures in adhesion have been reported.[2] The below study of Sauro *et al.* investigates the effects on the stability of the adhesion and the morphology of the interface dentin/Ionolux, by pre-treating dentin with blasting with bioglass 45S5 (Na/Ca phosphate layered silicate glasses) on the one hand and by working with abrasive paper on the other hand, both with and without pre-conditioning with polyacrylic acid. Since the simulation of a clinically relevant smear layer with abrasive paper has proven its effectiveness as a preparation method,[3] this scientific report presents the effects on the adhesion of the conditioning with polyacrylic acid.

Study design

32 human molars have been used for the test specimens. The occlusal enamel was removed and the coronal dentin exposed. Those teeth have been polished with abrasive paper (granulation of 320) under water for one minute, in order to imitate the formation of a smear layer. The test specimens were divided into groups with different dentin pre-conditioning. In group 1, Ionolux was applied directly on the dentin with no pre-conditioning. In group 2, the dentin was pre-conditioned with a 10 % polyacrylic acid solution. Ionolux was applied in bulk and light-cured for 30 seconds (Radii plus, SDI; 1000 mW/cm^2). The respective test specimens were further divided into subgroups and exposed to different ageing processes: 1) control group, no ageing (24 h storage in deionized water); 2) simulated masticatory forces (70 N, 150.000 cycles in artificial saliva); 3) 6 month storage in artificial saliva; 4) simulated masticatory forces plus 6 months storage in artificial saliva. Afterwards, the test specimens were each cut into 20 small sticks (cross-sectional surface of 0.9 mm^2) and the adhesion values were determined with an universal micro-tensile strength measuring device (maximum force 500 N, stroke length 50 mm, resolution 0.5 mm).

Results

The results of the micro-tensile strength measurements are presented in the chart below:

Average values ± standard deviation of the micro-tensile bond strength measurements [MPa] of the bond between dentin and Ionolux with different dentin pre-conditioning

	Control group no aging	Simulated masticatory forces	6 Months storage in artificial saliva (AS)	Masticatory forces & 6 month storage
1. No Conditioning	15.2 ± 5.3	12.4 ± 3.8	10.1 ± 4.2	9.4 ± 3.8
2. With Conditioning	19.5 ± 7.4	21.8 ± 5.5	7.2 ± 2.8	6.9 ± 4.6

In the control group without ageing the results of the micro-tensile strength measurements do not show statistically significant differences. However, the adhesion values of the dentin specimens, which were pre-conditioned with polyacrylic acid, stored in artificial saliva for 6 months and additionally affected with masticatory forces, are excessively reduced and lower than the values of the non-conditioned dentin specimens after appropriate ageing. These differences are statistically significant.
Furthermore, the interfacial morphology of the specimens was examined with confocal microscopy supported by rhodamine dye. It has been observed that the specimens, pre-treated with polyacrylic acid, show increased porosity in the hybrid layer between the dentin and resin-reinforced glass ionomer material under extensive ageing simulations, and are affected by nano leakage. This could explain the significantly low adhesion values. The authors assume that the hydrolytic degradation of the collagen fibers is favoured by the polyacrylic acid. This most likely happens through an activation of endogenous matrix metalloproteinases. Because of this, the interface of dentin/Ionolux is more sensitive to hydrolysis and degrades more with prolonged exposure to saliva than specimens without polyacrylic acid pre-treatment.
The authors conclude that modern glass ionomer materials can be applied directly onto sanded dentin without any problems. The smear layer formed during grinding does not hinder and requires no special conditioning with polyacrylic acid. This study therefore also confirms the published results of Inoue.[2] In fact, the risk of degradation of the interfaces during extended ageing, which is associated with the additional use of polyacrylic acid, is explicitly pointed out.

Conclusion: Ionolux, as a modern resin-modified glass ionomer, can be applied onto dentin without any restrictions and without having to remove the smear layer by pre-conditioning with polyacrylic acid. Actually, the conditioning with polyacrylic acid increases the risk of adhesion failure.

[1] Sauro S *et al.*, The effect of dentine pre-treatment using bioglass and/or polyacrylic acid on the interfacial characteristics of resin-modified glass ionomer cements, *J. Dent.* **2018**, *73*, 32.
[2] Inoue S *et al.*, Effect of conditioner on bond strength of glass-ionomer adhesive to dentin/enamel with and without smear layer interposition, *Oper. Dent.*, **2004**, 685.
[3] Armstrong *et al.*, Academy of dental materials guidance on in vitro testing of dental composite bonding effectiveness to dentin/enamel using micro-tensile bond strength (µTBS) approach, *Dent. Mater.* **2017**, *33(2)*, 133.