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Tensile bond strength of dentin adhesives on irradiated and nonirradiated dentin

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Introduction

"Radiation caries", a rapidly developing and highly destructive form of tooth decay, is a well-known consequence of radiotherapy. This is due to several effects of radiotherapy concerning even the dental hard tissues[1]. The irradiation damage of collagen fibers[2] could result in an impaired bond strength between composite and dentin, as has been described recently after high-dose irradiation[3].

Objectives

Since the effects of fractionally applied irradiation on adhesion of composites to dentin have not been described in the dental literature, the aim of the present study was to evaluate the influence of radiotherapy on the tensile bond strength of four different dentin adhesives on human dentin.

Material and Methods

One hundred and twenty caries-free freshly extracted human third molars were used in this study. Sixty teeth were irradiated with a total dose of 60 Gy (fractionally applied in doses of 2 Gy, five days weekly, over a period of six weeks). Specimens were prepared according to a special procedure described recently. Thus, simulation of intrapulpal pressure and dentin perfusion was allowed. The pressure was adjusted to 30 cm H_2O (Fig. 1 and 2).

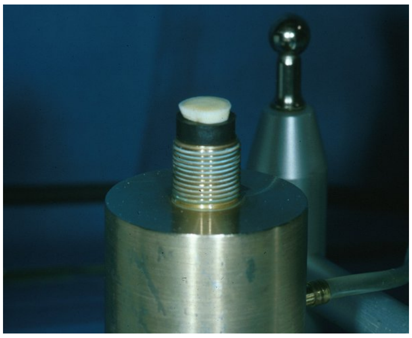

Fig. 1: Mounted dentin specimen on the perfused chamber.

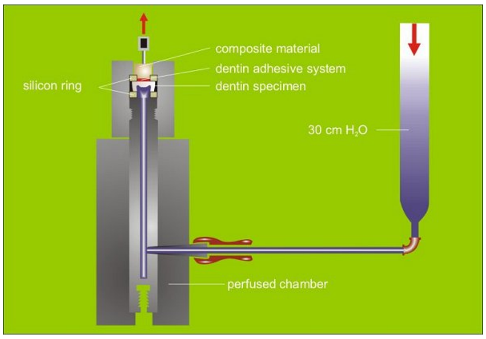

Fig. 2: Experimental apparatus designed to test tensile bond strength of composite resin on dry and perfused dentin specimen.

Both, the 60 irradiated specimen and the 60 nonirradiated specimen were divided at random into four experimental groups each. These groups were assigned to one dentin bonding agent used as recommended by the manufacturers (Table 1). A standardized metal ring was filled with the composite material (Tetric) in small increments. These were polymerized for 60 seconds. After polymerization, tensile bond strength was tested using an Instron Universal testing machine. The maximum tensile bond strength was recorded from a personal computer and graphically expressed. Bond strength was calculated. For each subgroup mean tensile bond strengths and standard deviations were calculated. Differences between irradiated and nonirradiated groups were calculated by using Wilcoxon test. Closed test procedure (based on the Kruskal Wallis test) was used to calculate differences between the different material groups.

Group	Material	Manufacturer	Composition
A	**Scotchbond™ 1**	3M Dental products, Loughborough, Great Britain	Ethanol, 2-hydroxyethylmethacrylate, bisphenol-A-diglycidyl-ehter-dimethacylat, urethandimethacylate, water
B	**Solobond Plus®**	VOCO,Cuxhaven, Germany	Primer: water, aceton, maleic acid, acid-functionalized, methacrylates, fluorides Adhesive: aceton, dimethacrylate, hydroxymethacrylate
C	**Prime&Bond™ 2.1**	DeTrey Dentsply, Dreieich, Germany	Dipentaerythritole-pentacrylate-phosphoric acid ester, urethandimethacrylate, bisphenol-A-dimethacrylate, butylhydroxytoluole, camphoroquinone, 4-ethyl-dimethyl-aminobenzoate, aceton, cetylaminhydrofluoride

D	**Syntac®**	Vivadent, Schaan, Liechtenstein	Primer: Tetraethylenglycolmethacrylate, maleic acid, dimethylketone, water Adhesive: Polyethyleneglycoldimethacrylate, maleid acid, glutaraldehyde, water

Table 1: Used dentin adhesive systems and their composition.

Results

Irradiation itself did not show any significant influence on adhesion of composite to dentin ($P > 0.05$; ANOVA). Regarding the adhesive systems, ANOVA revealed a significant influence on the tensile bond strength of both irradiated and nonirradiated dentin ($P = 0.0001$). Closed test procedure based on Kruskal-Wallis test showed that the tensile bond strength for the nonirradiated groups treated with Scotchbond^{TM} 1 was significantly higher if compared to Solobond Plus® and Prime&Bond^{TM} 2.1 ($P < 0.05$; compare Table 2 and 3). In the case of irradiated groups statistical analysis revealed a significant differences between Scotchbond^{TM} 1 and Solobond Plus® ($p<0.05$) and between Solobond Plus® and Prime&Bond^{TM} 2.1 ($p<0.05$).

$A^{irradiated}$	X			
$B^{irradiated}$	P<0,005	X		
$C^{irradiated}$	NS	P<0,05	X	
$D^{irradiated}$	NS	NS	NS	X
Group	$A^{irradiated}$	$B^{irradiated}$	$C^{irradiated}$	$D^{irradiated}$

$A^{control}$	X			
$B^{control}$	P<0,05	X		
$C^{control}$	P<0,05	NS	X	
$D^{control}$	NS	NS	NS	X
Group	$A^{control}$	$B^{control}$	$C^{control}$	$D^{control}$

Table 2 and 3: Statistical results (closed test procedure based on Kruskal-Wallis test) for the nonirradiated groups.

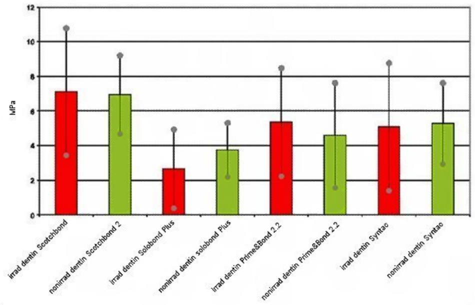

Fig. 3: Mean tensile bond strength and correlation within the different groups.

Discussion and Conclusions

In contrast to a recent publication by Pioch (1998), who described a reduced dentin bond strength after irradiation, this study did not reveal any significant differences between the irradiated and nonirradiated groups. Thus the described changes in dental hard tissues after irradiation obviously does not influence the bond strength of dentin adhesives[4,5]. The evaluated tensile bond strength of the used dentin bonding system was lower than described by other investigations. However, it should be kept in mind that most studies examined the bond strength without simulation of the dentin perfusion. Previous papers using the same experimental design have shown similar results[6]. The comparison (ANOVA) of the four dentin adhesives used in this investigation showed a significantly higher tensile bond strength for Scotchbond^{TM} 1. The more sensitively closed test procedure could not completely prove these findings. Regarding the dentin adhesive systems tested in this study, no significant differences could be observed between the irradiated and nonirradiated specimens. Thus the use of adhesive techniques to restore caries lesions in patients after irradiation can be recommended.

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