

Evaluation of bond strength of a conventional adhesive system in irradiated teeth

Avaliação da resistência de união de um sistema adesivo convencional em dentes irradiados

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Resumo

Introdução: Um dos tratamentos mais comuns dos pacientes portadores de câncer na região de cabeça e pescoço é a radioterapia, um método de tratamento que utiliza feixe de radiação ionizante e tem por finalidade destruir as células tumorais, minimizando danos às células vizinhas. **Objetivo:** Avaliar a resistência de união de um sistema adesivo convencional em dentes irradiados. **Método:** 24 terceiros molares, dos quais 12 foram aleatoriamente expostos à irradiação e preparados a partir da remoção do esmalte oclusal, expondo, dessa forma, uma superfície de dentina. O sistema adesivo Stae foi aplicado de acordo com as instruções do fabricante e em seguida acrescentou-se dois incrementos de resina de 2 mm. Os corpos de prova foram hemi-seccionados originando espécimes em forma de palito. Para avaliação da resistência de união, foi realizado o ensaio de microtração com carga de 500N e velocidade de 0,5mm/min. **Resultado:** Não houve diferença estatística significativa entre a resistência de união de dentes que foram ou não expostos à irradiação e que utilizaram um sistema adesivo convencional. **Conclusão:** Embora as doses de radiação aplicadas causem algum tipo de alteração em escala microscópica nos tecidos dentários, essas alterações não interferiram na resistência de união.

Descritores: Adesividade; radioterapia; resinas compostas.

Abstract

Introduction: One of the most common treatments of head and neck cancer patients is radiotherapy, a treatment method which uses ionizing radiation beam and destroys tumor cells, minimizing damage to neighbor cells. **Purpose:** To evaluate the bond strength of a conventional adhesive system in irradiated teeth. **Method:** 24 third human molars, 12 of which were randomly exposed to radiation and prepared from the removal of occlusal enamel, then exposed to a flat dentine surface. The adhesive system Stae was applied according to the manufacturer's instructions. Next, two 2 mm increments of resin were implemented. The samples were hemi sectioned specimens, originating shaped toothpick. To evaluate the bond strength, a micro tensile test was done with 500N load and speed of 0.5 mm/minute. **Result:** There was no statistically significant difference between the bond strength of teeth which were or were not exposed to radiation and which used a conventional adhesive system. **Conclusion:** Although the radiation doses applied may cause some alterations in microscopic range in dental tissues, it can be concluded that these alterations do not influence in the bond strength in dentin of irradiated teeth.

Descriptors: Adhesiveness; radiotherapy; composite resins; radiation.

INTRODUCTION

Once the survival rate of head and neck patients is increasing daily, the approach of a dentist becomes primordial to identify, to understand, and to manage possible alterations and late complications originated from the cancer therapy^{1,2}.

One of the most common treatments of head and neck cancer patients is radiotherapy, a treatment method which uses ionizing radiation beam and destroys tumor cells, minimizing damage to neighbor cells. This type of treatment, in specific cases, is applied singly or in combination to others therapeutic methods³.

Mucositis, osteoradionecrosis, xerostomia, salivary gland hypo function, oropharyngeal candidiasis, periodontal diseases, dental caries, and trismus are founded in patients both during and after radiation. Oral complications, as a result of the cancer treatment, are unavoidable. However, some of them are preventable, which represents the importance of the patients awareness of the prevention and management of radiotherapy-related oral complications⁴.

The tolerance doses of healthy tissues are around 60 Gy, and the sensibility of the tumor tissues varies from 30 to 60 Gy. The clinical

dose of radiation varies from 30 to 70 Gy, usually fractionated in daily doses of 1,8 to 2 Gy, in a period of 4 to 7 weeks, in accordance to the therapeutic planning^{5,6}. In this study, the radiation was applied for 27,6 minutes, producing a unique dose nearly 20 Gy. In accordance to Khan et. al.⁷, this radiation dose corresponds to a biological effective dose similar to that one obtained with 35 cycles of 2 Gy.

According to the hypothesis of which radiation doses may cause direct effects over hard tissues of the tooth, as well may cause morphological alterations of itself, and eventually to intervene in the way these tissues react to the process of union to the adhesive restoration materials, this study investigated the bond strength of a conventional adhesive system in irradiated and not irradiated teeth, with Cobalt 60 (Co- 60) in dentin⁸⁻¹⁰.

The null hypothesis tested is that irradiation does not intervene in the bond strength in dentin.

METHOD

Ethical Aspects

Twenty four third human molars provenients of the Buco-Maxilo Facial Surgery and Traumatology Departament of Federal University of Rio Grande do Norte (UFRN) were used by merited favorable opinion from the Research Ethics Committee of UFRN under the protocol number 45185715.8.0000.5537.

Selection of Teeth

The extracted teeth were stored in a solution of timol 0.5% at 4 °C until the moment of usage, aiming to avoid bacterial growth and alterations in the substract morphology. Then, the cleaning was made with water and soap, shaving with periodontal curettes, ending up with a pumice prophylaxis, made with a low-speed hand piece.

Afterwards, the teeth were randomly separated in two principal groups, one exposed to radiation and the other one unexposed, and so they were subdivided in four groups (n = 6), in accordance with the treatment received, as it shows at Table 1.

Irradiation With Co-60

Randomly, 12 teeth were exposed to radiation by Co-60 with the telecobaltotherapy (Theraton 780, Canada) machine at the Advanced Center of Oncology of LIGA Against Cancer of Rio Grande do Norte. In agreement to the International Agency of Atomic Energy (IAEA TRS 398), the pattern vehicle to calibration of the radiation beam is water.

According to the linear quadratic regulator, the teeth were submerged in 1.5 cm of distilled water, in a field of 18x27 cm, distance of font of 80 cm to the field 10/10 and depth of 0,5, adding

up to 70.13 cGy/min. The total amount of radiation time was 27.6 minutes, producing a unique dose of 1935,588 cGy. This dose corresponds to a total *Effective Biological Dose (BED)* similar to that one obtained with 35 daily cycles of 2000 cGy⁷.

Preparation of Teeth

Once the substract chosen was the dentine, the medium third of occlusal enamel from the dental crown was sectioned perpendicularly to its long shaft through a diamond disc cutter attached to a precision cutter machine (Struers Minitom, Denmark) under refrigeration, exposing a flat surface of dentine.

Next, the dentine was flattened, by using silicon carbide sandpaper (Bosch, German) of decrescent granulation 100 and 600, with abundant refrigeration in water, in low-speed (100 RPM). In line to each group, the adhesive system Stae (SDI, Dental Limited Block 8, St. Johns Court Swords Road, Santry Dublin, Ireland) was applied following the manufacturer's instructions. Then, two 2 mm increments of composite resin, Filtek Z350XT, color EA2 (3M ESPE, USA) or Aura, color DC3 or DC4 (SDI Limited. StreetBayswater, Brunsdon, Australia), were added, photoactivated (DB 685, Dabi Atlante, Brazil) for 20 seconds each, following the manufacturer's instructions. The LED's potency, measured by radiometer, was 1625mW/cm². After the confection of the samples, the teeth were stored in distilled water for 24 hours in stove at 37 °C.

After that, 3 sections were made parallel to the long shaft of the teeth on mesio-distal way, creating shapped toothpick samples with the medium thickness of 1 mm.

Evaluation of Bond Strength

To evaluate the bond strength, was used the machine EMIC DL - 2000 (EMIC, Brazil) with charge of 500N and microtensile speed of 0.5 mm/min.

Statistical Analysis

The statistic test used on the verification of Bond strength to the tested groups was ANOVA1 factor (one way).

RESULT

The Table 2 shows the results of bond of strength (MPa) obtained to each group, as its statistic meaning.

Once obtained the average of bond of respective groups, the results point that there was no statistically significant difference in bond strength of Aura and Z350 resins to the conventional adhesive Stae, regardless of the teeth were or were not submitted previously to controlled doses of radiation. It is relevant to observe that, in absolute amounts, there was a decrease of the bond strength

Table 1. Groups of study

NON IRRADIATED		IRRADIATED	
Filtek Z350XT + Adhesive Stae (G1)	Aura + Adhesive Stae (G3)	Filtek Z350XT + Adhesive Stae (G2)	Aura + Adhesive Stae (G4)

Table 2. Average and standard deviation of values of bond strength (MPa) to the composite resins tested

Groups	Treatment	Resin	Adhesive	Average (DP)	P*
G1	Control	Z350	Stae	21,66 (±9,14)	A
G2	Irradiated	Z350	Stae	17,33 (±13,19)	A
G3	Control	Aura	Stae	25,6 (±6,72)	A
G4	Irradiated	Aura	Stae	17,29 (±9,32)	A

*Same letters indicate absence of significant statistical differences (5%).

when compared to the same resin the teeth which were irradiated to the control group, even though it was not statistically different. Another important factor was the high standard deviation, mainly in groups which were submitted to radiation.

DISCUSSION

As it is observed in this study, the null hypothesis was accepted, for the reason that there was no statistical difference between the irradiated and not-irradiated groups.

Radiation caries, a quickly progressive and highly destructive type of the dental caries, is a well-known consequence of radiotherapy of malignant tumors in the head and neck region. Beyond flat surfaces, such as in occlusal or incisal borders, the radiation caries occurs frequently in cervical areas⁸.

According to Odum¹¹, adhesive restorations techniques seem to be greatly indicated in these cases. However, some authors, claims that composite resin restorations demonstrate a reduced longevity in irradiated patients^{12,13}.

The reduced longevity and the high frequency of deterioration plus recurrent failures in restorations in teeth of irradiated patients have been hugely studied^{12,13}. Hu et al.^{8,14}, observed the behavior and the lasting of dental restorations materials in teeth of irradiated patients, and suggested that the most common reason to the presence of failures on this restorations would be the material displacement with no clinical evidence of secondary caries at boundaries of restorations which got detached. Some studies presume, from then on, that the mechanical overlapping between the cavitory preparation and the restoration material could be damaged in teeth of irradiated patients^{8,14}.

This fact could be caused by many side effects of radiotherapy over hard dental tissues. Regarding to dentin, a significant reduced micro hardness was observed afterwards irradiation¹³. These effects are followed by a decreased stability of the dentin enamel junction after radiotherapy as well as a reduced resistance to wear¹⁵. Moreover, the injuries from radiation over collagen fibers may result in an inappropriate bond compression between the composite and the dentin, as described by Pioch et al.¹⁵.

In this present study, those 12 samples were irradiated with 1935,588 cGy, applied during 27.6 minutes, which dose corresponds to a total similar BED to that one obtained with 35 daily cycles of 2000 cGy. As opposed to Pioch et al.⁹, studies which observed a decreased bond strength in dentin afterwards using a unique irradiation dose of 100 Gy (to Superlux Prep[®]+++), but not to

others adhesive systems), this study did not reveal any statistically significant difference between the irradiated and not irradiated groups. These findings were supported by Gernhardt et al.¹⁶, which when evaluating the bond strength of 4 adhesive systems to irradiated and not-irradiated dentin did not observed any statistical difference.

According to some authors, the application of 30 Gy of ionizing radiation reduced the microhardness on enamel; however, after 60 Gy, none alterations were observed, and in accordance to results from other studies which did not find differences at enamel microhardness afterwards ionizing radiation¹⁷⁻¹⁹. Therefore, the alterations described at the crystalline structure of hard dental tissues afterwards radiation do not seem to affect the bond strength¹⁰.

The reduced micro hardness of irradiated dentin does not seem to influence the bond strength in dentin as well. Beside that, an influence of the collapse of dentin collagen matrix after receiving radiation did not get proved in this study¹³.

By using scanning electronic microscopy, Pyykönen et al.²⁰, did not find differences between specimens of irradiated and not irradiated dentin. This could be another reason to the findings in our study. Alterations on microhardness, crystalline matrix, may not influence in the bond strength of dentinary adhesive systems.

Tests using the same radioactive dose (60 Gy) show a short increase on microhardness of dentinary enamel regardless of the evaluated area. In contrast, the results associated to dentin show insignificant values, statically, which point some alteration equally to the enamel. It is important to notice that, in these studies, although the general microhardness of dentin does not suffer some significant alteration, generally, occurs a morphological disturbance which allows the microscopic observation of a amorphous surface and which makes it difficult to identify the dentinary tubules²¹.

On the study of Bernard et. al.¹², the changes resulting from irradiation on hardness, the crystal structure or the collagen matrix seems to influence the adhesive resistance of the adhesive agents to dentin, which corroborates to the study of Naves et. al.¹³, in which was observed that gamma radiation had a significant detrimental effect on the bond strength to both human enamel and dentin, when the restorative procedure was performed after radiotherapy. Liang et al.²² showed that, radiotherapy caused nano-mechanic alterations on both dentin and enamel, and this fact could increase its susceptibility to caries or still to promote a fast development of dental caries.

It may be observed that there is a lot of controversy surrounding this subject. And within the limitations of this study, another methodology, such as thermocycling (a alteration at temperature

to which the specimens are submitted may produce different results that allow to understand a little bit more about these restorations failures) may be used in view of the obtainment of new data which permits to understand more about these restorations failures.

As we realize, the conventional adhesive system used, as well the resin, did not propitiated significant alterations in the adhesion process to the irradiated teeth. We know that some modifications occur in structural levels and, mainly, are primordial at the adhesion process. To complement the methodology by new research

instruments is more than essential to improve the understanding of this dynamics and only then to apply in an improvement at the quality of life specifically in these patients.

CONCLUSION

Based on the results of this study, it can be concluded that the radiation did not promote any alterations in the bond strength of a conventional adhesive system.

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CONFLICTS OF INTERESTS

The authors declare no conflicts of interest.

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